AD-A048 284 OFFICE OF NAVAL RESEARCH LONDON (ENGLAND) F/G 5/2
EUROPEAN SCIENTIFIC NOTES. VOLUME 31, NUMBER 6,(U)
JUN 77 N M BLACHMAN, V S HEWITSON

UNCLASSIFIED ESN-31-6 NL

| OF |
ADA048284

END
DATE FILMED
2-78
DDC

(2) SC

OFFICE OF NAVAL RESEARCH
LONDON

EUROPEAN SCIENTIFIC NOTES

ESN 31-6

30 JUNE 1977

Distributed by the
Office of Naval Research Branch Office,
London

This document is issued primarily for the information of U.S. Government scientific personnel and contractors. It is not considered part of the scientific literature and should not be cited as such.

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

(14) 1. REPORT NUMBER: ESN-31-6

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE *(and Subtitle)*

(6) EUROPEAN SCIENTIFIC NOTES. Volume 31, Number 6,

5. TYPE OF REPORT & PERIOD COVERED

6. PERFORMING ORG. REPORT NUMBER

(10) 7. AUTHOR(s)

Nelson M. Blachman & Victoria S. Hewitson, editors

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

US Office of Naval Research Branch Office London
Box 39
FPO New York, NY 09510

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

(11) 12. REPORT DATE: 30 June 1977

13. NUMBER OF PAGES: 49

14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*

(12) 52p.

15. SECURITY CLASS. *(of this report)*: Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

AERONAUTICAL ENGINEERING	ELECTRICAL ENGINEERING
COMPUTER SCIENCE	MATERIALS SCIENCE
EARTH SCIENCES	OCEAN SCIENCES & TECHNOLOGY
ENERGY	PHYSICS

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by disclosing interesting information well in advance of the usual scientific publications.

The articles are written primarily by members of the staff of ONRL, with certain articles prepared by, or in cooperation with, members of the scientific

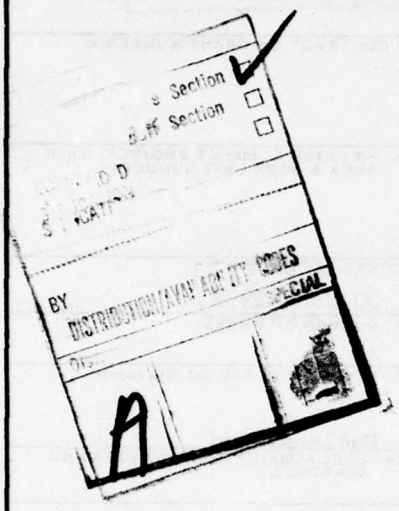
DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

265 000

ITEM #20 (cont'd)

staffs of the United States Air Force's European Office of Aerospace Research and Development and the United States Army Research and Standardization Group. Articles are also contributed by visiting Stateside scientists.



EUROPEAN SCIENTIFIC NOTES
OFFICE OF NAVAL RESEARCH
LONDON

Edited by Nelson M. Blachman and Victoria S. Hewitson

30 June 1977 Volume 31, No. 6

European Scientific Notes is Group II Newsletter type Class B periodical prepared and distributed by the Office of Naval Research London in accordance with NAVEXOS-P-35 prepared and submitted by the scientific and technical staff.

James H. Schulman
J.H. SCHULMAN
Scientific Director

L. Roy Patterson
L. ROY PATTERSON
Captain, USN
Commanding Officer

ONRL STAFF

Dr. A.I. Barcilon	Meteorology
Dr. J.B. Bateman	Life Sciences
Dr. N.M. Blachman	Electronics Engineering
Dr. W.J. Gordon	Mathematics
CDR D.A. Hart	Airborne Systems
CDR H.M. Jordan	Weapon Systems
Dr. M. Lessen	Mechanical Engineering
LCDR J.D. McKendrick	Ship Systems & Military Oceanography
Mr. A.W. Pryce	Acoustics
LCDR D.C. Rummler	Command, Control & Communications
Dr. V.N. Smiley	Optical Physics
Dr. W.G. Soper	General Physics
Dr. A. Sosin	Physics, Materials
CDR C.D. Stevenson	Undersea Systems

AERONAUTICAL ENGINEERING

THE X-114 AIRFOILCRAFT WING-IN-GROUND EFFECT VEHICLE

An exciting research project is underway in Germany, where the firm of Rhein-Flugzeugbau (a VFW-Fokker subsidiary) is constructing a six-passenger wing-in-ground effect (WIG) vehicle to explore further the performance of such vehicles, including operation in high sea states such as are encountered in the Baltic. The model X-114 airfoilcraft is in the final stages of completion and is understood to have been rolled out in April 1977.

The WIG condition is created by flying as close to the ground or water as possible. The airflow around the wing is modified from that in free flight, causing an increase in air pressure between the wing and the ground. This air cushion increases the lift while simultaneously reducing drag. The improvement in lift-to-drag ratio L/D is directly related to the specific power P/W, where P is vehicle power and W is vehicle weight, through the identity $Wv/P = \eta L/D$ with v the velocity and η the propulsive efficiency. The term Wv/P is known as the transport efficiency, which for an airfoilcraft (or WIG) is superior to that of a conventional aircraft.

Rhein-Flugzeugbau (RFB), located in Monchengladbach, started research on WIGs about ten years ago based on ideas of the famous German aerodynamicist Dr. A.M. Lippisch. After buying his patents on the concept, RFB began by building and testing models. One of the initial problems was to reduce drag at the hump speed where lift-off occurs. The model work also helped refine designs to improve stability. On the basis of their model studies RFB won a contract from the German Ministry of Defense to build and study a one-passenger airfoilcraft, the X-113, on which testing began in 1971. During the test program with the X-113, RFB gathered extensive data on the lift-to-drag ratio (L/D) versus altitude, and proved the value of WIGs for low power and fuel consumption while utilizing the ground effect.

RFB also perfected the design features necessary for successful ground-effect flight and, among other things, produced a highly stable vehicle that can be flown with hands off. The design of the X-113 made it self-stabilizing, and, by merely varying the throttle setting, the altitude could be changed while the attitude remained constant. An interesting feature of the X-113 was that it took about three times as much power to get over the step and into the ground-effect regime as was necessary for sustained ground-effect flight. It turned out, however, that this excess of power was sufficient for the airfoilcraft to fly freely like a conventional aircraft. Thus the X-113 could skim over the water in ground-effect flight and climb to altitude to fly over obstacles. The X-113 was a vehicle of approximately 5-m wingspan and was tested on Lake Constance and the North Sea in wave-heights up to 70 cm. Among the data derived from these studies are parametric plots relating drag, speed, and altitude to wingspan ratio.

After their experiments with the X-113, RFB had the necessary data to study analytically the capabilities and limitations of airfoilcraft. An extensive investigation of various classes and sizes of such vehicles was done for the German Ministry of Defense (MOD), and a report was prepared in June 1975. Among the conclusions was the thesis that airfoilcraft benefits become more attractive the larger the vehicle grows. In spite of the information gathered in testing the X-113, many questions remained unanswered, and it was proposed that a larger craft be built, primarily to assess the performance in higher sea states. The principal factor that influenced the design of the X-114 was the decision to build a vehicle for Baltic Sea testing and operation. Eighty percent of the time, the waves in the Baltic are less than 1.5 m in height. This consideration led to the dimensions and wingspan (8 m) of the X-114, and, with those parameters chosen, the X-114 turns out to accommodate six persons and to weigh about 1,530 kg. A photograph of a model of the X-114 is shown in the accompanying figure.

The X-114 airfoilcraft. When resting on the water, the craft floats on the two pontoons at the tips of the main wing sections. Roll control is exercised with ailerons on the winglets extending from the main wing tip/pontoon junction.

RFB's experience with WIGs puts the company in the position where they probably know more about the characteristics of these vehicles than anyone else in the world. Airfoilcraft are described as having an L/D ratio roughly intermediate between those of aircraft and conventional boats. The X-114 is expected to have an L/D of about 30 in ground-effect flight while traveling at about 81 kt. The L/D of an airfoilcraft is five times that of a surface-effect vehicle (i.e., Hovercraft), and the turning radius is far superior to that of a Hovercraft.

During testing with the X-113, turns of about 100-m diameter were demonstrated and, even more remarkably, the vehicle was unperturbed in yaw when the wingtips dipped into the water. Note from the photo that the design of the X-114 wing is such that when turning, the trailing edge is nearly parallel to the surface.

Plans for future activity by RFB call for construction of one X-114 for tests beginning in May 1977. The X-114 is primarily of fiberglass construction, a technology in which RFB has considerable experience, resulting from other projects such as the AWI-2 "Fantrainer" and the "Fanliner" (a light sports aircraft). The test results from the X-114 should be of considerable interest to the world's navies, many of which are conducting studies to identify the roles of unconventional vehicles in the future force structure. (CDR David A. Hart) Note: After this article was typed in final form, a photo showing the X-114 in flight was received and has been substituted for the model photo.

COMPUTER SCIENCE

A NEW APPROACH TO SPONSORING COMPUTER SCIENCE RESEARCH & DEVELOPMENT?

The UK Science Research Council's Computing Science Committee is proposing to break with its traditional methods of sponsoring research and development in two specific projects. Rather than funding the more promising proposals as they are submitted, the Committee is planning to request tenders for projects on the fundamentals of programming and distributed computing.

The motivation for the fundamentals-of-programming project is the relatively high cost of programming and the long time required to produce satisfactory software. One of the areas to be examined includes the basic process of software engineering and how program-development tools should fit together into an integrated whole. For example, should problem-oriented languages be implemented in a single system-implementation language and compiled through its compiler? At which point(s) in the program-development process should system-partitioning and structuring tools, library facilities, macro-processors, and program provers be applied? How should problem-oriented languages interface with simulation tools? How should emulators and module testers interface with compiler code generators? What are the static and dynamic implications of distributed computing on the linking and loading of computer programs? How do automatic programming systems supplant the foregoing development process? To answer these and other questions and to provide a basis for more efficient software development, the Committee is soliciting proposals for a £2M effort from software houses—that area of the industry where the effects of productivity are most pronounced.

Distributed computing probably has the most potential for reducing the hardware costs of existing large-computer applications. Moreover, by using microprocessors, it can also be applied to new application areas such as process control, signal processing, and operating-system implementation. To date, most efforts in this area of computing have been empirical without any attempt to develop the fundamental principles on which a distributed computing network should be structured. The Committee is proposing to fund, first, a two-year effort in discovering the principles. The second phase, lasting about three years, will involve experimental testing, and in the third phase distributed computing networks will be implemented. For the first time in this project the Committee is inviting competitive bidding from universities. Industry will also be involved through commercial consultations and university laboratory visits. Both of these efforts are being developed at this time and are being presented to the full Science Research Council this month. (LCDR D.C. Rummler)

EARTH SCIENCES

METEOROLOGY IN BOLOGNA AND ROME

I will describe briefly some of the activities in fields related to synoptic, dynamic meteorology as well as geophysical fluid dynamics observed in the course of my recent visit to Bologna and Rome. Research in these fields does not have a long history in Italy, for they are emerging disciplines that are trying to establish themselves in the face of great difficulties. The interested reader should consult other notes on this subject (*ESN* 30-4:155; 31-6:239).

Bologna is one of the oldest universities in Europe. Although its current enrollment is over 50,000, not all students attend the courses offered. The group I visited is located in the Department of Physics at the Istituto A. Righi and numbers about half a dozen young physicists who have abandoned research in theoretical physics and have turned their attention to analytical work in dynamic meteorology. The interest in this area and the motivation behind such work arose from a summer seminar given a few years ago in Venice by leading US and European researchers in these fields. The work of this group centers, for the most part, on the various aspects associated with the interaction of the large-scale atmospheric flows with mountain

chains such as the Pyrenees and the Alps. This research arose from the need to provide and extend accurate forecasts of the high tides in Venice.

Mountains can induce cyclogenesis; i.e., atmospheric flows can be deflected in such a way that cyclones can form in the lee of these mountains. This appears to be the case in the Alps, with these lows seeming to form often in the Gulf of Genoa. If stationary, these may affect not only the local weather in that part of the Mediterranean but also force oscillations in the Adriatic basin, resulting in high waters in Venice.

Dr. A. Speranza, an astrophysicist by previous university training, became interested in geophysical fluid dynamics after spending a year with Prof. W. Munk at the Scripps Institution of Oceanography in La Jolla, Calif., and an additional period at MIT. Speranza is presently working with Dr. A. Buzzi on a theoretical model in which the mountain is modeled as an elliptical disc or as a portion of a hemisphere. This work is to appear shortly in the *Journal of the Atmospheric Sciences*. Speranza is working on other problems related to mountain-flow interactions and wants to become involved in dynamical climatology.

At the time of my visit Dr. Anna Trevisan, who has spent some time in Oslo with Prof. A. Eliassen, was away at the National Center for Atmospheric Research (NCAR), Boulder, Colo. She has been interested in mesoscale numerical models in θ-coordinate with small mesh size (50 km); θ is a quantity related to atmospheric pressure and temperature which remains constant when an atmospheric air-parcel undergoes adiabatic displacement. In these models, both the Alps and the Pyrenees are represented by smoothed, idealized topography. The resulting flows seem to be in good agreement with observations.

Buzzi has spent several quarters at the Department of Atmospheric Sciences, Imperial College, London working with Dr. J.S.A. Green; aside from the theoretical work previously mentioned, Buzzi, with Dr. S. Tibaldi, published research on synoptic studies pertaining to the deformation of frontal systems as they cross the Alps. Part of such work has appeared in the *Quarterly Journal of the Royal Meteorological Society*, and a companion paper is due to appear soon in that journal. In this paper, Buzzi and Tibaldi propose a mechanism that may explain the low-pressure formation in the lee of the mountain. They argue that at low levels the interaction of the front with the mountain propagates upward via the thermal field and can affect the upper-air fields.

Dr. C. Pellacani has also spent some time in London in Green's Department. His main interest is in internal gravity waves in the atmosphere, particularly those found near an inversion layer at the top of the planetary boundary layer. Some of this work can be found in a recent paper in *Boundary Layer Meteorology* 9, 205-215 (1975). Finally, Dr. S. Rambaldi is working on flows past obstacles in the atmospheric boundary layer; he has also been interested in heat and momentum transport in that layer.

In Rome, the Istituto di Fisica dell'Atmosfera (IFA) numbers about 24 scientists, and its total yearly budget, including salaries, is about $1M. It seems that IFA suffers from a number of ills that affect research in Italy (see my article on "Research Climate In Italy," this issue). The Institute's research is applied and its main theme is the improvement of the quality of the environment, air being the primary fluid under study. Research is divided among four areas. The first deals with local circulation in the Rome area and involves development of numerical models coupled with an observational network. Dr. L. Dall'Osso is developing a numerical model capable of predicting flows on rather small scales (about 50-100 km or so). The numerical work is being done on an IBM 370-168 located in Pisa with terminals in Rome. Scientists working in this area interact with the Italian Meteorological Service also located in Rome. The second area of research deals with fog studies and the third with hail. Finally, meteorological data have been collected by the Collegio Romano (Jesuits) in various locations in Italy since the beginning of the 18th century; data, spanning some two and a half centuries, on temperature, humidity, precipitation, and wind are now available; and as a result, the fourth area of research at IFA is in charge of creating a data bank and of making such valuable information available for research both in Italy and elsewhere.

The Laboratorio di Ricerca e Technologia per lo Studio del Plasma nello Spazio is in Frascati, about 40 miles southeast of Rome. It started as a space-physics laboratory, and such research interests are still found in one of the four groups that comprise the Laboratory. The Space Physics Group is collaborating with Profs. B. Rossi and A. Lazarus of MIT's Space Science Department and with the Goddard Space Flight Center. The second group deals with the detection of the gravitational waves arising from the collapse of astrophysical bodies; J. Weber (Univ. of Maryland) started pioneering work into this area in the sixties. This group also collaborates with Profs. E. Amaldi and G. Pizzella of the Physics Department at the University of Rome and with similar groups in Munich, the US, and Russia. These waves are detected by very accurately measuring the length of a 1.5-m-long metal cylinder. Presumably passage of such waves could induce changes in length of the bar of the order of 10^{-14} to 10^{-15} cm, and, in order to reduce the noise, the metal bar is cooled to temperatures below 1 K. The cylinder is suspended magnetically to avoid parasitic vibration. There is a lot of controversy in this field, but it is a challenging one that pushes technology to its limits in a number of areas.

The third group deals with infrared astronomy and is about to install a telescope in Switzerland, where presumably conditions for observations are better. Finally, the Atmospheric Physics Group, numbering about eight scientists, is under the leadership of Professor G. Fiocco, who spent several years at MIT and at NCAR. The experimental work uses a Doppler LIDAR to measure the velocity of aerosols in the atmosphere; knowing the fluctuations in these quantities, one can compute the diffusion coefficients. They use the LIDAR to scan seven heights from the ground to the top of the atmospheric boundary layer. Acoustic sounders also provide qualitative information about velocity fields and to check some of the data. Some of this work is reported in *Atmospheric Environment* 8, 793-799 (1971). The theoretical work of the group deals with radiative studies in various atmospheric layers and energy exchange between aerosols and the atmosphere. For more details on this, the reader is referred to Fiocco's recent papers in *Journal of the Atmospheric Sciences* 33, (12) 2415-2424 (1976) and to *Journal of Atmospheric and Terrestrial Physics* 37, 1327-1337 (1975).

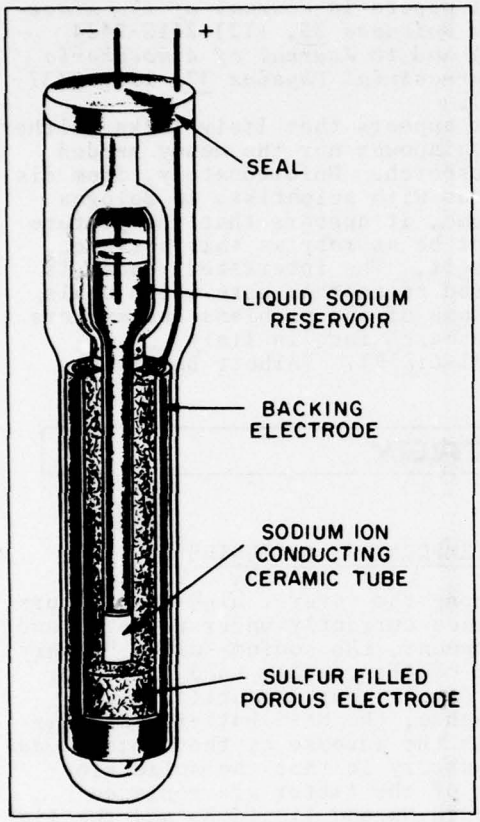
It appears that Italy lacks neither the brainpower nor the money needed for research. Unfortunately, from discussions with scientists in Bologna and Rome, it appears that the picture may not be as rosy as this article paints it. The interested reader is referred to another note which deals with some of the problems researchers and research face in Italy (*ESN* 31-6:239). (Albert Barcilon)

ENERGY

HIGH-TEMPERATURE BATTERIES

Among the several high-temperature batteries currently under research and development, the sodium-sulfur battery is one of the leading candidates for early development and utilization. In a sense, the Na-S battery (see figure) is the inverse of the common lead-acid battery in that the solid electrodes of the latter are replaced by liquid Na and liquid S, and the liquid electrolyte of the lead-acid battery is replaced by a solid electrolyte. Since ion transport through the electrolyte must be sufficiently rapid to allow battery operation, particularly at high currents, it may seem remarkable that a solid electrolyte can qualify. In fact, there are two types of alumina (Al_2O_3)-based ceramics under active production. These aluminas, which are quite similar in composition and structure, are called β- and β''-alumina. The Na^+ conductance of these ceramics at 300-350°C, the intended operating range, approaches that of Na^+ in water at room temperature. Furthermore, the transport of Na^+ is highly selective, and so the use of alumina for the purification of Na is also under consideration.

The operation of the Na-S battery, then, consists of the ionization of Na atoms with the transport of the resulting electrons through an external circuit and the concomitant transport of Na^+ ions through the alumina to the S bath, where sulfides of Na are formed.



Schematic Cutaway Diagram of a Na-S Cell

The high temperature is needed to achieve sufficiently high Na^+ transport through the alumina, and to sustain the sodium, the sulfur, and sodium sulfides (which are produced in operation) in a molten condition, to wet the ceramic. For electrical efficiency, the ceramic must preclude electron transport, readily achieved in this electrolyte. To minimize cell resistance and to form neutral sulfides, it is necessary to provide electron conductance in the sulfur electrode. Several techniques have been examined for this purpose, with the inclusion of graphite felt as the common method.

The Na-S battery was pioneered by the Ford Motor Co., with an eye toward electric-car propulsion. The power and energy densities of the Na-S battery are about five times those of lead-acid batteries because of the lower densities of the materials comprising the Na-S battery. Furthermore, the main ingredients in the battery—sodium, sulfur, and alumina—are plentiful and reasonably inexpensive. An average automobile range of 200-250 miles in a Pinto-sized car is anticipated. Other transport uses that have been suggested are delivery vans, urban buses, and railways.

Still another application for the Na-S battery—indeed, the one that may turn out to be the most important—is its use for energy storage and load leveling by electrical utilities. Both propulsion and utility applications can be met with similar battery designs.

Clearly, many factors require careful optimization in arriving at a battery for use in technology. In the US, work on the Na-S battery is being carried out in several laboratories, with the leading positions occupied by Ford Motor Co. and the General Electric Co. The basic patents for the Na-S battery belong to Ford, a fact that figures in the development plans of each laboratory.

To survey the position in the European laboratories, I visited five laboratories; their activities and positions are briefly described below. A more detailed account of these visits, preceded by a more extensive description of the battery will be issued as Technical Report, ONRL-R-5-77.

For the last three years, the British activities toward development of an advanced battery have been organized into a tripartite arrangement among Chloride Silent Power, Ltd. (CSP), the British Railways Board (BR), and the Atomic Energy Research Establishment (AERE). Each has its mission outlined, with a small, intentional overlap of activities and even a residue of competition to spice the work.

CSP retains the greatest portion of fundamental work; BR is more end-product oriented; and AERE (Harwell) plays an advanced-technology role, providing many of the services for which it has particular capabilities.

The economics of the Na-S battery retain considerable uncertainty for the British. The OPEC oil embargo resulted in a substantial reduction in consumer demand for electrical power, enough so that Britain currently possesses excess electrical capacity for base-line power and sufficient for

peak-power handling. The expectation of North Sea oil imports further eases any crunch that pointed to a dire early need for vast energy-storage systems. The transportation application for the Na-S battery is, therefore, the more likely one for early realization. The British position with respect to the Na-S battery is thus distinct from that of any other nation; the prime customer has been identified and the development of the battery is directed substantially toward this customer's requirements.

CSP (Runcorn, Cheshire) is a small member of the Chloride Group, Ltd., a worldwide company with capitalization of over £100M which produces over 10% of all the batteries in the Western nations. The manager of CSP is B. Halliwell; I. Wynn-Jones, the chief scientist, has been with the Na-S battery project since its inception, originally having worked on it at the Electricity Council laboratories in Capenhurst, Cheshire.

CSP's ultimate goal in Na-S battery development is a ten-year life. They currently have single cells that have been in 3-cycle-per-day operation for four years. The cells are designed to allow regenerative braking, which requires the capacity for a large charging current. The advantage in the use of regenerative braking is the economy (estimated at a 10% saving) of transforming a portion of the kinetic energy of the vehicle into stored energy in the battery rather than merely dissipating it as heat. There is a subtler advantage in regenerative braking, which provides braking when the driver's foot is off the accelerator pedal, much the same as with current internal-combustion engines. This is expected to help win driver acceptance. Other features of the battery receiving attention are "fuel" gauges. It is still undetermined whether a "power-used" or a "cell-voltage" gauge is better.

In addition to trains, one of the early market targets for battery use is electric city buses. The Chloride Group developed the "Silent Rider" bus powered by lead-acid batteries, and the "Silent Karrier" for city-center goods deliveries. These vehicles have demonstrated to the satisfaction of the management the developmental potentials of battery-driven vehicles of selected types.

CSP is developing a mixed β-β" alumina system, apparently similar to the ceramic system in the Ford Motor Co. battery program in the US. CSP regards the details of their alumina-tube fabrication as one of their key competitive capabilities; consequently, visitors are not admitted to this particular laboratory.

The electrolyte tubes developed by CSP have grown progressively larger. Recently, they have fabricated tubes of 3-cm diameter, 20-cm length, and 1.5-mm wall thickness. CSP feels confident that they can soon provide tubes three times as long, with less than 0.1-mm variation in length between tubes, roundness to 0.1-0.2 mm, and straightness to 1.5-2 mm over the entire length.

A detailed optical- and scanning-electron-microscope study by G.J. May and S.R. Tan on the influence of microstructural defects on the tensile strength of β-alumina leads them to conclude that alumina, for optimum mechanical properties, should have a uniformly fine-grained structure and should be free of defects larger than about 10 μm.

CSP has performed elemental analysis of the ceramic to determine the extent of contamination of the ceramic introduced by other cell elements, particularly the container material. Their results indicate no such contaminants in their prototype cells. Nevertheless, they have reversed an early design and now place the Na on the outside of the alumina tube and the S on the inside to minimize even potential contamination.

CSP conducts a very large testing program on Na-S cells. Their facility allows the simultaneous operation and full monitoring of 300 cells. The operation of the tests is automatic; charge and discharge cycles are carried out for the entire bank of cells together.

The operations at BR are a bit smaller in size, with about 25 staff members, but they obtain services from supporting groups at their central laboratories. Like CSP they are also looking toward longer alumina tubes, but currently are working on 16-cm lengths. Unlike CSP, they produce their tubes by a batch process, encapsulated in MgO to minimize Na_2O loss during sintering; they can produce about 20 tubes in a single batch,

occupying a sintering furnace for one day to include heating up, sintering, and cooling down times. Their ceramic tubes look very good, and BR people confidently state that they have solved any corrosion and humidity problems.

BR's activities, under the direction of J.L. Sudworth, are expected to progress along the following schedule, leading to a decision concerning scaling up for production. In early 1978, they expect to statically test a 50-kWh battery composed of 300 100-Ah cells. In 1979, they will test a 400-kWh battery, the size required on the railways.

Railways are, by tradition, extremely safety conscious. As a result, BR has required a design that immobilizes the Na within the battery in case of accident. Glass and metal spheres were used previously for containment. Attention currently appears to have passed to full battery-containment of any rupture, avoiding the capacity penalty that spheres—even hollow ones—might incur. To test this concept, BR has used an old war-time bomb shelter and has exploded cells within it. A typical configuration is a cluster of seven cells in a closely packed configuration; i.e., a central cell surrounded by six outer ones. The central cell is caused to explode and the effects on the others are observed, with the entire arrangement subject to various conditions. The temperature pulse that results from the rapid mixing of Na and S through an explosion is recorded. BR is delighted to report that the effects of such violent scenarios are so slight that it is difficult to find any visual effects on post-inspection or on the characteristics of the cells that were not exploded.

Prime responsibility and the major effort for the French development of the high-temperature Na-S battery lies with the Compagnie Générale d'Electricité (CGE) in their laboratory in Marcoussis, a rural suburb about 25 miles south of Paris, under the direction of Dr. J.P. Dumas.

The French strategy is notably different from that of the British, Americans, and Germans. The French have chosen to develop the β-alumina electrolyte, not β". In addition, the "green-state" fabrication method (i.e., the initial step) that the French are using is electrophoresis, a method that has been used by few others (e.g., General Electric, US) in this application.

The decision to proceed with β-alumina may fit the CGE purposes well. Their market goal is electrical-energy storage. Little attention has been given to vehicle-propulsion applications, since automobile producers in France have failed to respond to the possibility of Na-S-propelled vehicles. The poorer Na^+ conductance of β-alumina, compared with that of β"-alumina, is therefore less significant to the French.

The heart of successful electrophoresis lies in choosing the best slurry solution medium and providing a reactive powder. CGE is still working on both, with considerable success already. The media tend to be organic liquids, and CGE's current favorites are proprietary. CGE's tubes are beautifully white (implying an absence of troublesome defects), very smooth, and can have (nonstandard) wall thicknesses as low as 0.2 mm.

The CGE treatment starts with the preparation of reactive alumina and its deposition on a stainless-steel mandrel by electrophoresis. The deposit is dried on the mandrel in an oven and the tubing is simply slipped off the mandrel, an act that I still find somewhat amazing, considering the state of the ceramic, the dimensions, etc. The free-standing tube is pressed isostatically; the last step is the sintering treatment. Laboratory tubes have been sintered in large enclosure blocks of alumina that were previously produced. These blocks were drilled to provide the holes for the insertion of the pre-sintered electrolyte tubing. Since this is expensive, they are moving to alternative encapsulation geometries.

It has been the opinion of competitors that this process is too costly, particularly with the requirement for a large number of stainless-steel mandrels with requisite surface smoothness. CGE has performed an economic analysis of their electrophoresis method and has concluded that it is essentially equivalent in cost to competitive ones.

Lifetimes for batteries in storage applications must be long, and CGE's best records here are a Na-S cell that has been run in a glass enclosure for

6000 hours and a cell in a metal enclosure for 4000 hours.

Although production of the ceramic electrolyte has received major attention, the rest of the battery is still in the design state, and a demonstration system is under construction. This deliberateness in approaching a full battery system is dictated somewhat by uncertainties in the French policy and energy strategy. A further complication is the competition to Na-S batteries from the air-Zn battery, also under development at CGE.

Somewhat over three years ago, BBC (Brown, Boveri et Cie, Heidelberg) made an evaluation of competing energy-storage systems and concluded that the high-temperature Na-S battery appeared most attractive. Furthermore, their experience seemed applicable since BBC had spent considerable effort on a ZrO_2 electrolyte for fuel cells. Accordingly, a multigroup union was developed, BBC was charged with overall responsibility, battery design, assembly, and electrolyte research. Battelle Institute (Frankfurt) is the other major laboratory involved. Professor H. Felzer (Univ. Konstanz, FRG) is the structure specialist, using his extensive background in x-ray analysis, and Dr. A. Divecek (Kernforschungsanlage, Jülich, FRG) is most concerned with the sulfur chemistry, mainly the formation and characteristics of the several sodium polysulfides that form during battery operations. In addition, Friedrichsfeld GmbH (Mannheim), a ceramic-processing firm, is currently tooling up to take over larger-scale electrolyte processing after a period during which the technology is transferred from BBC to them; Friedrichsfeld's experience has been mainly in structural ceramics, and technical ceramics pose a new challenge to them.

Among the several groups and countries involved in the Na-S battery development, BBC is a late entry. Understandably, their efforts to date have been largely directed to "playing catch-up," but Dr. Heer showed some of BBC's results that are interesting and impressive. Perhaps the most interesting one is the BBC success with MgO additions to the β-alumina electrolyte instead of the more commonly used Li_2O. They have achieved an electrical (ionic) resistivity at 300°C of 5 ohm-cm or less, occasionally down to 3 ohm-cm; fabricated tubes with wall thickness down to 0.7 mm in short lengths and 1.5 mm in tubes with longer lengths (20 cm) and diameters of 1 in.; achieved densities 98% of theoretical; and, perhaps most impressively, operated Na-S cells in an overflow arrangement for more than 6000 Ah-cm^{-2} at a current density of 0.9 A-cm^{-2}.

The BBC successes with MgO-alumina are even more impressive when one considers that they have used amounts of MgO additive varying between about 1.5 and 3.3 mole-% and found little difference. Their current belief is that too much importance has probably been attached to composition itself. Instead, the microstructure appears to be the dominant consideration.

In addition to the solid electrolyte, BBC has examined other aspects that contribute to cell performance. The geometry of the graphite cell in the S compartment can be important. The viscosity of S and the polysulfides that form during operation, as well as immiscibilities between the sulfides, has suggested that the felt may be improved by holes located next to the electrode. The holes are about 4 mm in each dimension. Measurements of cell voltage during a charge-discharge cycle do indicate improvement with this modification. The BBC interpretation of this problem is that, without the holes, sulfur droplets are formed at the electrolyte surface, giving rise to an electrically insulating layer that defeats the purpose of the graphite felt. In still another development, BBC added less than 1 mole-% of Se to the S, to reduce the viscosity of the melt. The improvements realized here are comparable with those effected by the felt-geometry method. Of considerable concern has been the observation of Si on the ceramic-tube wall after extended cell cycling. The source of the Si is the stainless-steel current collector for the sulfur compartment; stainless steel is a candidate for battery-containment material.

BBC is optimistic about the Na-S battery. Their plans call for the development of a small demonstration battery by the end of 1977.

Battelle is BBC's major partner in the German effort. Battelle has been charged mainly with cell operation, and one of their main concerns has been cell corrosion. They have tested Cr-Ni steels (both austenitic and ferritic), carbon steels, and some proprietary iron-free "superalloys." Typical corrosion rates

reported in this study are about 5 μm in 1000 hours in the best cases, namely the proprietary superalloys. By comparison, the carbon steels may show a decrease of several hundred μm in thickness.

The most promising recent development at Battelle for the Na-S battery is the adaptation of a stainless-steel felt for immobilization of the liquid sodium. The porosity is between 80 and 90%, a value that certainly is not apparent to the naked eye. The use of any immobilizer involves a loss in capacity in the cell plus an extra economic penalty in itself; balanced against these are the beneficial features of safety in case of crash and the opportunity to use the Na-S battery in a horizontal configuration, as automotive application may require. (A. Sosin)

ELECTRICAL ENGINEERING

IEEE-EUREL-URSI EUROCON '77—COMMUNICATIONS

The first Eurocon—European Conference on Electrotechnics—was held in Lausanne, Switzerland, in 1971 under the sponsorship of Region 8 (Europe and environs) of the Institute of Electrical and Electronic Engineers (IEEE). In 1974 the second such conference took place in Amsterdam, this time with the additional sponsorship of Eurel—an association of 13 Western European countries' electrical-engineering societies that had been formed in 1972. The third of these triennial conferences, also sponsored by the Union Radioscientifique Internationale, was held 3-6 May 1977 on the Island of San Giorgio Maggiore, a two-minute boatride from St. Mark's Square in Venice. No mention was made of this background, however, in any of the several ceremonial Conference talks—evidently because of embarrassment over the largely American character of the originating sponsor. English, nevertheless, has continued to be the one language of the Eurocon, replacing the Latin or French that was once the medium for international discourse.

Since the Fondazione Giorgio Cini, in whose buildings the 1977 Conference took place, serves as the site of many meetings each month, it seems worthwhile to describe its history and its facilities. The island's church and Benedictine monastery date from around 1600, but they fell into ruin after about 1825. In 1951 Senator Count Vittorio Cini initiated a project to remove the barracks that had been erected during WW II on the island, restore the monastery and Church of San Giorgio, and use a large portion of the former for cultural purposes. The trade schools set up in the monastery's precincts contain dormitories and dining facilities, but the portion given over to scientific and cultural meetings has only a bar, and the conference lunches came out of individual, very full cardboard boxes at $6 each. Although the restoration maintains the mood of renaissance Venice, the other conference facilities are quite up-to-date.

Approximately 700 people attended the 1977 Eurocon, at which nearly 200 papers from 26 countries were presented. The sessions were broadly classified under the headings: communications in large electric power systems, new developments in communications, communications and computers, communications in signal processing and medicine, and communication problems in developing countries. The topics of the up to seven simultaneous sessions were often hard to distinguish from one another, thus producing some session hopping, which was facilitated by closed-circuit TV presentations listing the current and next papers in each meeting room.

The best talk in the opening plenary session was that of A.A.L. Reid (British Post Office Telecommunication Systems Strategy Dept.), whose theme was the conflict between development and inertia in planning new telecommunication services. It results from uncertainties as to both future costs and customer demand. A monopoly, he explained, must maintain a consensus of its clientele, thus heeding more the complaints of those disadvantaged by changes in its services than the expressing of satisfaction of those benefiting from innovations.

The 27 papers on communications in large power systems revealed a great deal of interesting communication work involved in transmitting status and control information for electrical power-distribution networks. Interference from the high power, and transformations in the mode of propagation

of signals sent over power lines introduce new problems. An interesting British proposal for solving them is to transmit the signals via the regular medium-wave radio broadcasting system by means of added subaudible frequencies.

Among the 31 papers on medical electronics were several on aids for the handicapped. In the discussion of one of these it became clear that, although sensory feedback from a prosthesis would be highly desirable, the necessity of implanting electrodes in the afferent nerves (in order to send information to the brain) makes it impractical. In contrast, signals from the efferent nerves (intended for the muscles) can readily be picked up on the surface of the skin and used to control the prosthesis.

Other papers dealt with diagnostic signal processing, image processing, telemetry, and communications in the delivery of medical care. In the case of the 250-bed King Faisal Specialist Hospital in Riyadh, Saudi Arabia, which opened in 1975, 11 interlinked Digital Equipment Corp. PDP minicomputers are connected with visual-display terminals and specialized equipment throughout the facility to take care of all administrative and technical routines, from admissions to intensive care. Patients are referred to this hospital who, in the past, would have been sent to Europe or the US for treatment. Its information system was developed and installed by Searle and by the London firm Scientific Control Systems Ltd. (SCICON), but efforts are underway to train local personnel to maintain the system.

While this installation provides some of the most modern technology to a developing country, the 31 papers of the sessions on communications in the developing countries emphasized that the 100 such countries are a very diverse lot, having two-thirds of the world's population and a tenth of its property. Prof. Björn Wellenius (Univ. Chile, Santiago) pointed out that, while communication facilities are growing at about 5 to 7% per year in Europe and North America, the rate can be as high as 20% per year for several years in a row (and even more for short periods) in some developing countries, e.g., Brazil. Such high growth rates bring with them difficulties in providing sufficient trunks for new subscriber facilities as well as in raising capital and expanding the administrative structure. Without additional subscriber lines, however, an increase in the number of trunks would only result in more "busy" signals, as the existing lines are very heavily used. At the same time there are communities in Brazil without telephones that would express no interest in acquiring any if they knew of the medium. In such places the cost of providing telephone service would be several hundred times as great as in Europe, but it is generally felt that rural services must be subsidized.

The 83 papers falling under the rubric "New Developments in Communications" were presented in two or three parallel sessions. These papers covered a wide variety of topics, including coaxial-cable, satellite, waveguide, radio, and optical-fiber transmission. There were also presentations on Viewdata and on the Philips videotelephone, which are discussed below, as well as on a system developed at the Delft University of Technology for the digital transmission of the pen motion in handwriting and sketching over a telephone line along with the usual analogue speech.

G.T. Sharpless (Mullard Research Labs., Redhill, Surrey, UK) described the experimental prototype of an "intelligent" home terminal, which provides advanced facilities for Viewdata and Teletext (*ESN* 31-2:72), viz, cassette recording of over 300 pages and the electronic storage of four pages of information; these permit the off-line composition of Viewdata messages to be sent when completed. Its 8-bit microprocessor and 3-Kbyte program memory permit it to offer games that exercise the mind, in contrast with the usual finger-exercising TV games. It appears to fill a need that can be expected to grow rapidly in the next few years as Viewdata and Teletext become fully operational in Britain and perhaps in other countries, too.

Speaking on Viewdata itself, S. Fedida (Post Office Research Centre, Martlesham Heath, Suffolk, UK) made use of an impressive three-cathode-ray-tube projection-TV system built by Zygma Electronics Ltd., London, to exhibit clearly to an audience of about 200 the data and figures coming interactively over a telephone line from Britain to his Viewdata adapter. With the aid of the same telephone line, Viewdata was on display throughout the Conference, eliciting a great deal of

interest—particularly in its economic aspects. Those who supply information for its databanks will be charged a fee for the privilege but will be compensated by the users of their data, except in the case of advertising.

Also on display was the Philips (Hilversum, Netherlands) 1.3-MHz-bandwidth videotelephone, but its wide use in the Netherlands is considered to be far off as a result of experience with a network linking 60 Philips and Dutch PTT people in five cities. They were found to have little interest in using it except for transmitting graphical material. Conference speakers from several countries indicated that videoconference facilities can be useful in eliminating intercity travel to some one-day routine meetings of people who already know each other, but facsimile transmission rather than a new wideband videotelephone network for ordinary subscribers seems the solution to the need for sending written or graphical material.

Finally, in addition to a small display of several manufacturers' posters, the exhibition of equipment included online demonstrations of the European Informatics Network (EIN) via a leased telephone line to Ispra, Italy. The EIN has been established to link various computer facilities by Cooperation Européenne dans le Domaine Scientifique et Technique (COST), which involves 12 countries but is entirely separate from the Euronet, a data-transmission network being set up by the post-telephone-telegraph services of several Western European countries. Different operating philosophies are required in these networks because the PTT's are obliged to guarantee that an entire message gets to its destination once its transmission begins, whereas a looser approach to the delivery of message packets suffices for computer networks.

The EIN at present has five nodes, at Milan, Ispra, Paris, Zurich, and London, each of which is linked to a battery of local computing facilities with its own distinct resources and operating systems. The EIN provides the necessary translations between high-level languages to make all of these facilities readily available at any point in the network. The 29 Conference papers on "Communications and Computers" dealt with these and other national and international data networks as well as with the use of microprocessors in the routing of traffic.

The Conference Proceedings, bound in two volumes totaling 1357 pages of the European A4 standard size (8.3 x 11.7 in.), are available for $50 from the Associazione Elettrotecnica ed Elettronica Italiana, Via Monza 259, Milano 20126. They provide a great deal of background concerning communications in developing countries as well as a picture of current work toward improving upon the system of 400 million telephones and other devices with which the world now communicates. (Nelson M. Blachman)

ELECTRICAL ENGINEERING AND ALLIED TOPICS AT BEER-SHEVA

Although Beer-Sheva can be traced back to 4000 BC, the present city dates from 1900 AD, when its site was selected as the headquarters for the Turkish administration of the Negev Desert's Bedouin tribes. In the interim Beer-Sheva had served only as a watering place for passing flocks. By the time the State of Israel was established in 1948, this village had attained a population of 2000, which has now grown to over 100,000—particularly as a center for the settlement of new immigrants. These immigrants come largely from Arab countries as well as from the USSR, Eastern Europe, and South America.

The Negev is a 5000-mi^2 semi-arid region representing 60% of the area of Israel but containing only 10% of Israel's population. The Negev's population, however, is growing five times as fast as that of the rest of the country. Beer-Sheva has 8 inches of rain per year, but most of the Negev, which lies to its south, has less than half that much, and its water needs must be supplied mainly from sources in the farthest (northeastern) corner of Israel. There the water is available at a level comparable with that of the Sea of Galilee, 690 ft below sea level, and one-fourth of Israel's entire energy supply is consumed in pumping her water up to where it is required, Beer-Sheva, for example, being 930 ft above sea level.

In 1969 the Ben Gurion University of the Negev was established as a regional institution to make Beer-Sheva and the Negev more attractive to immigrants. It concentrates on the particular problems of the desert in addition to providing teaching facilities in all of the usual fields. Because the educational level in the other Middle Eastern countries is generally low, the University includes a preparatory school for adults, demobilized soldiers, and immigrants to bring them up to the standard required for admission. The University has about 4000 students and a faculty of about 1000, half of whom are full-time members while the rest have full-time jobs elsewhere and are teaching in order to augment their meager salaries.

The Electrical Engineering Department of the University, currently headed on a rotating basis by Professor Daniel Tabak (PhD, Univ. Ill., 1967), is located near Beer-Sheva's bus station in a building that had once been intended for a covered market. It is somewhat crowded, with its 350 undergraduates, 30 graduate students, 15 faculty members, and 6 laboratories. Its classes therefore meet either on the old campus, where the other departments of engineering are presently located or, a little further away still, on the new campus 1.3 miles to the northeast. The 5- to 6-story concrete buildings on the new campus are of striking modern architecture and are placed in attractive and practical clusters on the campus.

The Department was established in 1967 and was operated under the supervision of the Technion until 1973. It now has the right to grant BSEE and MSEE degrees; the right to grant doctorates in electrical engineering is expected later this year. Undergraduate classes meet all day long and lead to a BSEE in four years; graduate students' classes begin at 3 or 5 p.m., since they usually have full-time jobs elsewhere.

The Department's well-equipped research laboratories are devoted to: medical electronics, microelectronics, magnetic instrumentation, electro-optics, energy conversion, and computing. The Computer Laboratory has a DEC PDP 11/40 digital computer with 28-K core memory, two 1.2-million-word disk memories, fast paper-tape and punched-card facilities, analog-digital converter, line printer, and 8 teletype terminals. These are also 3 Yokagawa analog computers, and the Department has access to the University's CDC Cyber-73 digital computer.

The faculty includes several immigrants from Leningrad, and so a good deal of Russian can be heard around the Department. A much larger number of faculty members, however, both natives and immigrants, have earned their PhDs at US universities, and several others were obtained at the Technion. The faculty's research topics cover a very broad range—as diverse as their backgrounds—and only a few of these topics can be touched upon here. Support for this research comes from a variety of sources, including subventions from the West German government and the general university funding for the building up of the Department, which seems to be more generous than at the older university-level institutions in Israel.

Dr. Nathan (Norman) S. Kopeika is continuing the work he had begun at the University of Pennsylvania on the use of inexpensive neon indicator lamps for the detection of millimetric radiation. He has found that 5-mm radiation increases the current drawn by the lamp from a dc source that maintains a discharge. By using a large array of such microwave detectors and processing their outputs in parallel, Kopeika expects to be able to produce microwave holographic images of buried objects and of weapons carried on the bodies of human beings. The latter application demands a very low incident power and thus exploits the sensitivity of the glow lamps for detecting low-energy, nonionizing radiation whose only known effect on humans is thermal—and this only at intensities exceeding 10 mW/cm^2. Kopeika finds that his glow lamps can reach the ideal, blackbody-background noise-equivalent-power sensitivity limit with a received reference power as low as 1 mW in heterodyne detection.

He is trying to extend his work on gas glow discharges to the detection of infrared radiation in the 8-14-μm range and also ultraviolet radiation, the mechanism in the latter case being the photo-ionization of atoms excited by the applied dc field. He describes this effect as being almost like a laser in reverse, and he is hoping to be able to produce an inexpensive, rugged, sensitive uv detector.

Dr. Jonathan Molcho is investigating the estimation of skin blood-flow velocity by measuring the Doppler shift in the light scattered by the moving red cells in the skin. To monitor the density of blood clots and their sizes in stored blood and in infusion lines, he is studying the spatial distribution of the energy scattered from an ultrasonic beam by the clots.

The research of Professor Dan Censor, head of the Electromagnetics Group, to which Kopeika, Molcho, and Dr. Ben-Zion Kaplan (head of the Magnetic Instrumentation Lab.) belong, has dealt with ray phenomena in moving, absorbing media and nonlinear optical media. He bases real and complex ray-tracing on an extended Fermat principle, taking relativistic considerations into account. In investigating electromagnetic dispersion and ray-tracing in moving, lossy isotropic and anisotropic media, he has applied the relativisitic formalism without separating the constitutive parameters into susceptance and conductance. Such a separation, although tacitly assumed by many authors, is not possible in general. Censor has succeeded in explaining why, as has been observed, conduction-current and polarization-current models lead to the same dispersion equation, and he finds that this is true not only to within a first-order approximation but in general.

The Communication Group consists of Professors Israel Korn (PhD, Technion, 1968) and Eugeny Plotkin (PhD, Leningrad Electrotechnical Institute of Communication, 1963). Korn is in the process of putting together a digital-communication laboratory, and his present work involves the theoretical computer simulation of amplitude-shift keying to determine the error probability with and without feedback in the presence of noise and intersymbol interference. In the early seventies he spent three years in the US—two of them at NASA/Houston—studying *inter alia* the capacity of delta-modulation with feedback.

Plotkin is continuing work he had begun in Leningrad in the late sixties and early seventies on nonlinear filtering for the rejection of a signal with unknown parameters, such as a sinusoid whose frequency is known only to lie within some band. In its simplest form, his approach involves the use of two identical linear, all-pass filters L, two four-quadrant multipliers, and a high-pass linear filter H that is fed the difference of the multipliers' outputs. The inputs to one multiplier are both Lx, where x(t) is the waveform to be filtered; the other multiplier is fed x and L^2x (i.e., the input Lx to the other multiplier after passing through the second linear filter L). The nonlinearly filtered output is thus $y = H[(Lx)^2 - x \cdot L^2x]$, which vanishes when the input x is a sinusoid.

The performance when a signal is present along with the sinusoid is not so obvious, but Plotkin has experimentally found

$$y = (k^2x + L^2x)(L^2x) - (k^2Lx + L^3x)(Lx),$$

where k^2 is a constant gain factor, to be highly effective in eliminating sinusoidal interference with an amplitude-shift-keyed signal, and its action seems almost instantaneous. He has tried two different forms for the filter L; one of these has frequency response $(1 - j\omega\tau)/(1 + j\omega\tau)$, and the other $(b - ja\omega - \omega^2)/(b + ja\omega - \omega^2)$—both being realized by means of operational amplifiers with suitable feedback. A paper on his "function-elimination filter," which includes a theoretical analysis and experimental results, has been accepted by the *International Journal on Circuit Theory and Its Applications*.

In the Physics Department (cf. *ESN* 29-11:487), S.K. Mil'shtein, a Russian immigrant formerly at the Institute of Solid State Physics of the Academy of Sciences of the USSR and later the Racah Institute of Physics (Hebrew Univ., Jerusalem), has been studying the effects of dislocations in semiconductor crystals. He is concentrating particularly on the p-n junctions formed by single dislocations, which produce diodes capable of high-frequency operation. The production of single dislocations is more art than science, according to Mil'shtein. He makes "misfit" dislocations by epitaxial growth. Mil'shtein's latest paper (*IEEE Trans. Electron Devices*, October 1976, pp. 1184-5) illustrates the strong rectification obtained when current flows through a tungsten microprobe situated at the point of emergence of a 60° dislocation in n-type silicon and the lack of aging of the diode constructed on this single dislocation. Two earlier papers by

Mil'shtein dealt with the dislocation-induced shift of the absorption edge in silicon [*Phys. Lett.* 54A, 465 (1975)] and the changes in the electron-state spectrum of plastically deformed silicon by the diode effect [*J. Appl. Phys.* 46, 3894 (1975)]; both of these papers study the effects of high-density dislocation clusters.

Dr. Yigal Horowitz, also of the Physics Department, has been concentrating on the neutron-induced thermoluminescence (TL) of LiF and CaF_2 phosphors, motivated by the use of these materials in separating the components of mixed neutron-gamma radiation fields. TL dosimeters are devices containing phosphors that store energy when exposed to a radiation field and release this energy as light when the phosphors are gently warmed. The light emission, either peak or integrated intensity, is a measure of the radiation dose. The response of the phosphors to different radiations depends, among other things, on the composition of the phosphor, the type of radiation, and the energy of the radiation. For example, Li^6F has enhanced thermal-neutron response as well as response to x- and gamma-radiation, while Li^7F has much less response to thermal neutrons.

Horowitz and his colleagues have been studying the neutron response of LiF over a broad spectral range for the different isotopic varieties of LiF. Their purpose is twofold: to obtain information for practical dosimetry, and to elucidate the mechanism that causes a dependence of the response of this TL phosphor and others on the "linear energy transfer" (LET); i.e., on the linear rate of deposition of energy in the phosphor by the radiation. There is considerable disagreement in the literature concerning the precise form of the LET curve for LiF, and Horowitz is now trying to determine whether there is a universal TL-LET response curve for this phosphor by irradiating a variety of dosimeters containing LiF under controlled conditions with protons and alpha particles of various energies.

Horowitz *et al* have also shown that the thermal-neutron-induced dose is not necessarily negligible compared with the gamma-induced dose in mixed neutron-gamma radiation fields for TL dosimeters. For this purpose they use manganese- or dysprosium-activated CaF_2 phosphors to evaluate the gamma component of such mixed fields. The work on LiF is in press in *Radiation Research*, and the work on CaF_2 is in press in *Physics in Medicine Biology*.

Although there is no work on fiber-optic communications, Dr. V. Volterra of the Physics Department is interested in the physics of glass. He has a Binational Science Foundation project with T. Litovitz (Catholic Univ. of America, Washington, DC) on the diffusion of alkali ions in silicate glasses. Volterra uses nuclear magnetic resonance (NMR) and finds that the NMR relaxation time is correlated with electrical measurements made in Litovitz's group. Volterra has also been studying the Raman spectra of alkali-silicate glasses, and he believes that he has identified three phases: SiO_2, $Na_2O \cdot SiO_2$, and $Na_2O \cdot 2SiO_2$. He finds that the proportions of these components change with composition and temperature. At the moment Volterra's facilities for glass synthesis are rather limited, and he looks forward to developing a more sophisticated glass-melting laboratory.

The various faculties we visited are relatively young and enthusiastic, reflecting the dynamic growth of Beer-Sheva, its University, and the opportunities afforded there for both natives and immigrants. (Nelson M. Blachman and James H. Schulman)

INFORMATION THEORY IN TRIESTE

Despite the turmoil in other Italian institutions (*ESN* 31-6:239), things have been proceeding normally at the University of Trieste, where a more old-fashioned attitude flourishes among the 12,000 students despite the open enrollment policy (*ESN* 26-5:125) and the certainty of graduation with the *dottorato*—the only degree offered in Italy (*ESN* 30-7:303). This attitude can perhaps be attributed to Trieste's proximity (6 miles) to the Yugoslavian border, which affords rather free passage for going to work and for shopping to those living nearby on either side. Perhaps it derives from Trieste's formerly having served as the seaport for the Austrian part of the Austro-Hungarian

Empire. [Fiume (Rijeka), 40 miles to the southeast, played this role for the Hungarian part.] Or perhaps it results from the adequacy of Trieste University's facilities in contrast with the terrible overcrowding in some other Italian universities (*ESN* 30-4:155).

Within the Istituto di Elettrotecnica e di Elettronica of the University's Faculty of Engineering, Professor Giuseppe Longo heads a very small group working in the field of information theory. Although Longo has only eight students in his information-theory course—three from the Mathematics Department and five from Electrical Engineering—Trieste ranks as important in this field because of the international summer schools Longo has been organizing 38 miles to the northwest in Udine for some years and because his proposal—that a future IEEE International Symposium on Information Theory be held near Trieste—may one day be accepted.

In their first two years the engineering students, who work hard despite pressure on the faculty to pass all of them, take basic courses in mathematics and sciences. In their last three years they study applied topics—six at a time—with three options for electrical engineering: communications, control theory and computers, and electronic devices. Altogether there are 70 or 80 students in the final three years of EE, which usually stretch into five years by the time a student has successfully finished all of the necessary examinations. These are entirely oral and can be scheduled at almost any time the student wishes. Longo has introduced an innovation, however, which he picked up while teaching at Cornell—written quizzes throughout the duration (15 November to 15 May) of the courses he teaches, which include mathematics for engineers as well as information theory. The students grudgingly admit the quizzes are helpful in learning the material and in assessing their progress, but they feel it would be impossible if quizzes were given in all six of their courses. There are no courses for graduates in Italy, but Longo has found an unusual way to overcome this impediment in his own case: he has obtained two *dottorati*—one in mathematics and the other in electrical engineering.

There is an effort underway to abolish the examinations for the posts of assistant professor and full professor. The examination conferring the right (*libera docenza*) to teach at a university without providing a post at which to exercise it has already been eliminated. Both of these "reforms" are causing consternation among those wishing to maintain standards (*ESN* 30-4:155).

The Istituto di Elettrotecnica e di Elettronica; i.e., the Electrical Engineering Department, has 7 full professors and 30 associate professors including both internal and external. In addition there are assistant professors (who do research and also lead the exercise sessions of courses), fellowship holders, and graduate technicians. Andrea Sgarro, a mathematician, falls into this last class but is already serving Longo as an assistant professor and is expected to receive this title shortly. Together they constitute the entire information-theory section of the Department, but their research output is considerable despite Longo's claiming to be able to devote only a tenth of his time to research. He is, in addition, writing a book on information theory, which will be the first in Italian, and he is serving as editor for all of the conference publications emanating from the "Centre International des Sciences Mécaniques" (CISM) in Udine.

Each year, with the joint support of the Consiglio Nazionale delle Ricerche (CNR), CISM offers a series of about ten advanced summer schools usually conducted in English on various topics in mechanics, mechanical engineering, mathematics, and information theory, including "Information in Large Systems," organized by Longo in 1976, and "New Trends and Problems in Information Theory" as well as "Fundamental Analysis Techniques for Signals and Systems" in 1975. These courses last between one and six weeks with four or five hours of lectures per day plus panel discussions delivered by well-known authorities from the US, Europe, and Israel. Springer Verlag publishes the proceedings of an appropriate selection of these courses, and Longo goes to Udine each week to coordinate this publishing.

Both Longo and Sgarro have spent some time visiting the Mathematical Institute of the Hungarian Academy of Sciences in Budapest, where they collaborated with Imre Csiszár and with János Körner, who, in turn, spent an extended period at CISM. (The CNR

occasionally supports specialists' visits to Trieste or Udine for 2 to 6 months.) Some of the results of this collaboration have been "Two-Step Encoding for Finite Sources," by Körner and Longo [*IEEE Trans. Inf. Theory* IT-19, 778-782 (1973)], which made extensive use of graph theory, and "On the Error Exponent for Source Coding and for Testing Simple Statistical Hypotheses," by Csiszár and Longo [*Studia Scientiarum Mathematicarum Hungarica* 6, 181-191 (1971)], which improved estimates of the error-probability exponent by applying Rényi's statistical interpretation of the entropy of order α.

An example of the collaboration between Longo and Sgarro is the paper on "Information Networks and Collateral Information" [*Alta Frequenza* 45, 661-666 (1976)] dealing with the joint capacity of two single-input, single-output channels having correlated inputs when each of the outputs thus provides collateral information that aids in the decoding of the other. They have also submitted a joint paper, "The Source-Coding Theorem Revisited: A Combinatorial Approach," to the 1977 IEEE International *Symposium on Information Theory*, but a competing meeting in Genoa seems unfortunately likely to preclude their getting to Cornell University to present it. This paper is intended to provide a clear explanation for the appearance of entropy and Kullback's "discrimination" (information divergence) in the error-probability exponent for source coding in the stationary, finite-memory case. It will be submitted to the *IEEE Transactions on Information Theory*, to which Sgarro recently sent "Noiseless Block-Encoding for Weighted Information." The latter describes the set of rates at which noiseless source coding is asymptotically possible when errors are not permitted for those sequences whose total weights exceed a prescribed threshold; i.e., when such sequences must be represented by distinct codewords.

Another recent paper of Longo's, "A Noiseless Coding Theorem for Sources having Utilities" [*SIAM J. Appl. Math.* 30, 739-748 (1976)], shows that, as the coding block length grows infinite, the average code-word length should approach the source's entropy independently of the utilities assigned to the source letters for a discrete memoryless message source. He concludes that a finite block length (possibly 1) is optimum. In addition, Longo has published some related but more philosophically oriented papers in recent years in the *Atti dell'Istituto Veneto di Scienze, Lettere ed Arti* concerning "Information and Utility," "Probability and Information," and "Fuzzy Sets and the Notion of Uncertainty"—all in Italian. In August and September 1977, Longo will visit the Electrical Engineering Department of Imperial College, London, and he will participate in the NATO Advanced Study Institute on Communication Systems and Random Process Theory in Darlington 8-20 August, presenting a "Review of Algebraic Coding and Combinatorics" there.

Thus, it is clear that Trieste (with a population of 300,000) is a small but very active center for information theory. (Nelson M. Blachman)

GENERAL

"TRANS-TEC '77" CONFERENCE: TECHNOLOGY TRANSFER AND THE GOSPEL ACCORDING TO MARKS AND SPENCER

Conferences on technology transfer often tend to provide a "blinding glimpse of the obvious," to pluck a phrase from one of the contributed papers, or to wander off into a number of by-paths including the trail that leads to the Enchanted Land of Innovation. As a rough definition, technology transfer is the transfer of techniques, methods, devices, or equipment from their original realm of applicability to successful utilization in another field of activity. And, because information flow, education, and good communications are required to transfer almost any kind of modern technology, there are understandable tendencies to identify one or the other of these as THE key element or to equate these essential components with the transfer operation itself. These temptations were reasonably well avoided in the Trans-Tec '77 Conference held under the auspices of the Committee of Directors of Research Associations in London, 9-10 May 1977, and even the glimpses of the obvious

often provided some interesting new perspectives.

There are about 30 industrial Research Associations (RAs) in Britain providing consultative and R&D services to a wide range of the economy, from agriculture to the construction industry (the paint, paper, scientific instruments, ceramics, steel castings, and rubber and plastics industries are just a few of the other areas served). The sizes and operating methods of the RAs vary; some have their own laboratories, while others prefer to place research contracts with external laboratories. The RAs are thus in a most advantageous position to transfer technology from one sector to another, and they organized the Trans-Tec '77 Conference to improve their efficacy in doing so.

The driving force behind the Conference was Britain's currently weakened economic situation, which has further aggravated the UK's poor industrial performance. Many of the leading papers analyzed the economic changes that have altered Britain's industrial position. They discussed various strategies for British industry and generally exhorted management, labor, and politicians to adopt appropriate attitudes and policies, and take the necessary imaginative and unselfish action to cope with the low British productivity and impaired industrial competitiveness. Recognition was also given to the fact that Great Britain is now part of the EEC; two speakers representing the European viewpoint were among those featured. Some of the salient points of these talks will be reported further on in this article. The American way of doing things was also in the back of everyone's mind; US practice, as a good or bad example, was mentioned many times during the meeting. But the principal emphasis was on Britain's own industrial scene, an intriguing panorama of large internationally known companies at the forefront of technology set into a much larger community of small, conservative firms using comparatively traditional methods.

Perhaps the major theme expounded for the benefit of both these components of the British industrial establishment was that the UK (along with the rest of the world) is virtually awash with new and useful technologies, and that all one has to do is to make a determined effort to scoop them up and use them. To drive this point home, one speaker (A. Tiffany of D. Gurteen & Sons, Ltd.) said that the RAs could abandon research for the next decade and concentrate on helping manufacturers to pick up the technology already available. S.S. Carlisle (Scientific Instruments Research Association Institute) went still further. Pointing out that the cost ratio for research: development:production engineering is 1:10:100, he complained that governmental support does not reflect these proportions. He argued that a correct national policy for science and technology would allocate more funds for investment in technology transfer than in R or R&D. He even questioned whether the British government should continue to fund certain kinds of R&D on the assumption that it is industry's job to exploit it; for, if industry in fact shows no tendency to exploit the R&D, there is no point in funding it.

Notwithstanding these excerpts, there was no real anti-research sentiment nor serious suggestion that there should be a moratorium on research. What was being expressed, it seemed to me, was frustration and a self-critical impatience with all aspects of British social, political, educational, and industrial structures that make Britain incapable of doing what other countries like the US, Germany, and Japan do rather well—the transitions from science to technology to manufacture.

Many of the papers concentrated on modern methods of locating existing technology, selling it to management, and motivating and training workers to use the imported technology. Thus, a number of the talks emphasized the utility of computerized information systems as well as taped systems for audio and TV instruction and demonstration.

One of the biggest hits of the meeting, however, was a talk dealing with the transfer of rather simple technology by simple methods. It was given by Nathan Goldenberg, Scientific Adviser to Marks and Spencer, Ltd., the clothing and food merchants whose name is a British household word, with hundreds of retail establishments in the UK. Goldenberg explained how a firm that does not produce anything itself can nevertheless promote technology transfer by practicing what everybody says are obvious principles:

strong management support, direct person-to-person dealings, ordinary hard work, and common sense—plus use of the vast store of knowledge that is available practically for the asking. Since these elementary precepts were dramatically effective in the less-developed segments of the British economy, they are probably a good recipe to follow for transfer of technology to the less-developed countries. I sensed a general response by the audience that even high-technology industry could use more of the Marks and Spencer ingredients in addition to modern technology-transfer paraphernalia.

Not being familiar at first hand with the practices of large merchandising companies, I am perhaps overly impressed with the M&S approach; undoubtedly, all large companies of this type everywhere employ their buying-power leverage to improve the quality and lower the prices of their own brand-name goods by setting their own specifications and making suppliers compete for their business. But the Marks and Spencer approach, according to Goldenberg, goes well beyond that point; it involves the merchant as a prime agent for the transfer of technology between industries that manufacture for him. In some cases it has required M&S to perform an act as simple as teaching Turkish sultana (raisin) producers to dry the fruit on platforms off the ground and bag it in containers used only for that purpose, thus giving a hundred-fold reduction in the stone and grit content of M&S cakes. At other times it has involved somewhat more sophisticated efforts, such as tracking down the origin of "off-flavors" introduced by the wrong kind of food-packaging materials. And it frequently has produced new grades of products or has stimulated an entire industry whose major market lies outside of the Marks and Spencer organization.

The M&S technique is to assign one of their technologists (some of whom have only "craft" knowledge, although most have technical degrees) to work personally with the manufacturers of the commodities sold by M&S and, when necessary, with the suppliers of the manufacturer's raw materials. Thus, in dealing with the "off-flavor" problems M&S technologists have dealt not only with the printers of their food-wrapping labels but also with the makers of the printing ink, from whom they elicited important information, not known to the printer, on the composition of some inks and the volatile products of their oxidation. The ultimate result was the establishment of a new category of printing ink known as "Food Quality." A similar intermediary role of M&S technologists between Turkish suppliers and UK bakers created a new grade of sultanas marketed worldwide; there are the ordinary grade and a "Marks and Spencer" or "Goldenberg" grade of Turkish sultanas!

Perhaps the most impressive result of the M&S technology-transfer technique was the creation of a UK egg industry, which had been non-existent in the early fifties when M&S baked products were made from frozen eggs imported from China or Australia. Although the price of these eggs was high and their quality was variable, there seemed little alternative because of the unsuitability of UK-produced eggs for the purpose. With M&S technologists as intermediaries between a few willing UK egg suppliers and the bakers, it was established that the UK eggs had the wrong viscosity for baking purposes. On the hypothesis that the long storage of the frozen Chinese and Australian eggs in transit might be responsible for their superior qualities, experiments were carried out on UK eggs, and a procedure was developed to freeze, store, and thaw the frozen eggs under controlled conditions to obtain the proper viscosity. Thus the three-way cooperation of M&S technologists, a few egg producers, and some bakers led to the establishment of a UK egg industry, which Goldenberg estimates has saved Great Britain roughly £200M of foreign exchange on that item alone during the past 20 years!

In one of the introductory papers, Sir Ronald McIntosh (National Economic Development Office) stressed the extreme importance of non-price factors—designs of high reliability and technological content—pointing out that a price advantage, such as that introduced by the depreciation of a nation's currency, can rarely offset competitive disadvantages of other kinds. Indeed, Britain's problems have grown even worse with its currency depreciation rather than better, he said. The fall in the UK's share of world trade has been most marked in those sectors of

industry where technological advance has been most rapid. Reducing the cost of the British product has not been successful in combating this loss. In the area of sophisticated engineering products, where world trade is growing most rapidly, good design, reliability, and fitness for use are dominant, and price can be almost totally irrelevant, Sir Ronald said. Without the importation and utilization of new technologies to improve the quality of British products, he predicted that Britain will continue to manufacture products of relatively low value, which the more alert nations are leaving behind, and to import relatively high-value products—going in just the opposite direction from the one she should be taking.

Because of the long lead times involved in much R&D, McIntosh suggested that the UK might very well consider a major increase in purchase of foreign technology (93% of the Western World's R&D is done outside of the UK), taking out licenses to manufacture advanced products of proved performance. He decried the lack of collaboration between suppliers and users in the higher-technology manufacturing sector and the failure of large industries, such as the six major nationalized industries, to use their leverage in influencing design policies. McIntosh observed that the failure of British industry to use modern technology has affected the smaller companies most—those that supply machines and components to other parts of UK industry—and so these smaller firms have become uncompetitive even in the domestic market. The difficulty shows up most markedly when there is a spurt of industrial recovery in Britain; production bottlenecks then arise, and British customers must turn to foreign sources for a quick supply of machines and components, causing the UK's imports of manufactured goods to increase sharply.

A. Rawlinson (Department of Industry) reviewed some of the steps that the Government is taking to help disseminate existing technology and to encourage its application to immediate industrial problems. These include the establishment of a free advisory service for design and manufacturing as well as an information-retrieval service. He spoke also of the need to encourage mobility of people between different sectors of British science and technology—a perennial problem that seems insoluble in Britain, or indeed, in Europe.

On the broader European scene, R.K. Appleyard (EEC, Brussels) reviewed the Community's policy on technology transfer. He pointed out that indirect measures within the EEC will be the most important ones in stimulating the transfer of technologies. These indirect measures include the patent system; support for university R&D, other public-sector laboratories, and research associations; the establishment of organizations such as the National Research Development Corporation (NRDC) in the UK; fiscal incentives towards innovation; public purchasing policy, and the delineation of standards.

Most of these measures have hitherto been dealt with in a national framework, but the EEC is gradually trying to achieve coordination and common action in regard to them. One of the actions is the Euronet project to set up an EEC-wide network for computerized exchange of scientific and technical information among data banks throughout the community (see *ESN* 31-5:177.) Another is the establishment of an organization whose role within the EEC will be similar to that of the NRDC in the UK and ANVAR (Agence Nationale de Valorisation de la Recherche) in France, both of which assist in the commercial exploitation of R&D. Appleyard once again emphasized that the bulk of national and international support has been given to the R&D aspect of innovation, whereas other links—particularly those dealing with technology transfer—have been rather neglected by governments.

A more detailed analysis of the European scene was given by Walter Zegveld of the Netherlands Organization for Applied Scientific Research (TNO), a government-chartered organization with a staff of 5,000 and a budget of approximately $140M per year. Zegveld said that we are now experiencing the end of an economic era because of changed trading terms for energy and raw materials; the increased emphasis on environmental considerations, safety, and conservation of resources; the saturation of industrial countries' markets for some products; the humanization of labor and the changing international divisions of labor. These developments have reduced or entirely eliminated the relative advantages that led to the rapid industrial expansion of European economies

in the last few decades, and they have made Europe a less attractive place for a number of industries, especially those which use elementary technology. This indicates that European industries should concentrate on producing materials and providing services with high added value or technological content.

Zegveld strongly emphasized that the problems associated with technological change are inescapable, even in a "zero-growth" society, and that policies to deal with them, including those for technology transfer, will become more important in the future. Thus, the role of governments in promoting technical change in industry will become greater; European (and American) governmental support for R&D has gone beyond the general aspects of university research support to the development of marketable products and processes, first in defense and advanced new energy systems, and spreading into other areas previously left entirely to private industry. Correspondingly, governmental concerns with a "science policy" are increasingly being converted to a concern for a much broader "science-technology policy" closely connected to economic and sociological problems. Zegveld indicated that European governments are now looking at the restructuring of industries before they get hopelessly into trouble rather than afterward. However, he warned, governments measure their activity by the amount of money they devote to it in their budgets, and in many cases they are actually throwing away a large amount of money in prestigious-sounding but ineffective projects. Companies often use these monies to finance their second-rate projects.

Discussing the role of technology in innovation, Zegveld reviewed the rather indirect action of two separate circuits, the "scientific circuit" and the "industrial circuit." Zegveld maintained that there is a need for explicit technology-transfer programs to couple the two circuits more closely. He warned, however, against the danger of pushing government-supported laboratories too far into short-term development in an effort to make them more "relevant," and against the equal danger of neglecting government laboratories while the money is put into various collaborative schemes based on a vague feeling that the government should pay more attention to industry, "where the action is." Zegveld reiterated that since there is a chronic tendency for industry to underinvest in long-range research, it is clearly of mutual advantage for the government to concentrate on fundamental and longer-range research while industry concentrates on experimental development and commercialization. This, however, increases the need for technology transfer.

Zegveld then reviewed some of the European programs underway that involve technology transfer in the restructuring of industries in the UK, the Netherlands, France, and Germany. In the matter of transfer of products and processing ideas from the research to an industrial phase, Zegveld gave very high marks to the UK's NRDC, which he said had performed a pathfinder role. Other countries, including Japan, Canada, India, and New Zealand, have adopted this type of organization. The EEC has suggested that more countries should consider the establishment of agencies like the NRDC. After mentioning a number of programs underway in Sweden, France, the Netherlands, and the UK designed to involve universities with industrial firms, he concluded that large computerized information-retrieval systems have not proven to be as successful as originally expected. "Technology transfer," he said, "is, especially for the smaller and medium-sized firms, a matter of agents and not of agencies."

Reprints of the Trans-Tec '77 papers can be obtained from the Committee of Directors of Research Associations, 47 Victoria Street, London SW1H 0EQ, England, at a cost of £30. (James H. Schulman)

FRANCE'S VIIth PLAN

On 28 June 1976, the French National Assembly adopted the Seventh Five-Year Plan, which provides broad economic guidelines for the government, industrialists, and unions for the years 1976 through 1980. It also provides a rational means for orchestrating the various needs of the country and matching these with the country's output. It is therefore an important line of communication between the various sectors of French society. (The reader is referred to ONRL Technical Reports R-10-75 and R-11-75 for a

summary of the objectives of France's six consecutive plans.)

The Plan is prepared in four steps, each of which spans a three-year period. These consist of (1) preliminary studies, (2) choice of the main themes and orientations, (3) detailed elaboration of the Plan, and (4) approval by the various governmental bodies. In stage (1), an initial-value or forecasting problem in economics is posed, and a study is carried out to obtain a five-year projection of the country's economic developments and needs. Several scenarios are developed, depending upon which areas are emphasized. Governmental bodies like the Commissariat Général du Plan (the body whose duty is to set up and coordinate the elaboration of a new Plan) and the Ministry of Finance as well as several Commissions, consider the various alternatives and scenarios. For the preparation of the VIIth Plan there were 13 Commissions (Energy and Research being two of them) composed of a representative cross section of the population: businessmen, workers, union leaders, farmers, as well as government experts. These Commissions are divided among four groups: (i) those dealing with a certain activity (agriculture, industry, energy, etc.); (ii) those that look into the developmental aspects of the country's economics (employment, etc.); (iii) those deciding on the orientation of certain sectors (education, health, etc.); and, finally, (iv) those dealing with regional development.

In the second stage the main themes are chosen on the basis of the reports from the various Commissions. In the third stage the Plan is elaborated in detail on the basis of the chosen priorities. The final phase deals with the acceptance and ratification of the Plan by the various governmental bodies. During its five-year existence, the performance of the Plan is monitored by economic agencies.

The drawing-up of the VIIth Plan took place under difficult conditions: a worldwide energy crisis with its impact on industrialized countries poor in energy resources, a monetary crisis, and a demographic crisis. (The 1945 French war babies' search for jobs has prevented a substantial decrease in unemployment.)

The three main aims of the VIIth Plan are: full employment, a reduction of the inequalities within French society, and improvement of the quality of life. To fulfill the first, the government is seeking ways of matching the demand for jobs with the training of new graduates. This aspect has met with some resistance (see *ESN* 30-12:540). Also, in both university research and in industry, the government is attempting to decentralize away from Paris. The western, southwestern, and central regions of France are slated to benefit most since these, at present, suffer from high unemployment. The reduction of inequalities within French society might be achieved by reducing the spread of incomes, providing equal chances for all pupils entering school, introducing preventive medicine, and enlarging the field of cultural activities. To improve the quality of life the government wants to introduce a 40-hour week, to better working conditions, and to prevent the exodus from the farmlands to the cities and from the centers of towns to the suburbs. It proposes to expand the new towns, develop medium-sized ones, and improve housing, especially old buildings; furthermore, the improvement of public transportation and the creation of green spaces around cities are also high on the priority list.

The government hopes to reduce inflation to 4.5% per year by 1980, an ambitious undertaking! To reach such a goal the Plan foresees a reduction of imports of fuel and an increase in the local production of energy capable of satisfying 35% of France's needs by 1980 (only 25% of these needs are currently covered by local sources). It also intends to increase exports, especially to the Third World. By 1985, this scenario also calls for no more than 15% of France's imports to come from any one country. To achieve these goals, the government has set up 25 *programmes d'actions prioritaires* (priority programs). These programs can be classified under any one of these six themes: give a shot in the arm to the French economy, reduce inequalities, improve the quality of life, reach full employment, expand research, and consolidate foreign relations. Critics claim that the resources set aside to carry out these 25 *programmes* are too small to provide much impact, especially for the second theme. Furthermore, the calculations are made on the basis of a relatively stable economic situation and would therefore fall far short if the system is slightly perturbed.

Nevertheless, in their characteristic Cartesian frame of mind most Frenchmen feel that the Plan is probably a good thing to have, even if its objectives are rarely met. (Albert Barcilon)

COUNCIL FOR SCIENCE AND SOCIETY: SAFETY AND SUPERSTAR TECHNOLOGIES

Measured by any criterion such as the professional reputations of its members, the Council for Science and Society (CSS) is the leading organization of British scientists active in the sphere of social aspects. (For a report on a more vociferous group, with lesser means and less well-known membership, see *ESN* 28-12:489 concerning the British Society for Social Responsibility in Science.) CSS was formed in 1973, funded by a bequest of £80,000 from the Leverhulme Trust. Its stated purpose is "promoting the study of, and research into, the social effects of science and technology, and of disseminating results thereof to the public." Although it claims that its "primary task is to stimulate informed public discussion in the field of 'the social responsibility of the scientist,'" it is more active in identifying "developments in science and technology whose social consequences lie just over the horizon...."

Two activities of the CSS are reviewed here—a Conference on Risky Ways to Safety: Technological Assessment and Public Benefit, held at Imperial College on 16 May 1977, and a working party report, entitled "Superstar Technologies."

The Conference, chaired by Prof. John Ziman (Univ. of Bristol), a well-known theoretical physicist, was opened with an introduction by Sir Brian Flowers, the chairman of the committee that recently issued the "Flowers Report" on nuclear hazards for the UK. He ventured the hypothesis that risk is, itself, acceptable (if the amount is not excessive) but that irreversibility is unacceptable; i.e., society is willing to accept risks if it retains the option of reversing itself later. Opposition to nuclear-reactor development, in this framework, is (at least, in part) due to the view that future options concerning radioactive disposal, for example, are effectively irreversible. Flowers also pin-pointed an ethical dilemma: Under what conditions can we impose risks on those who will not benefit? More generally, How do we attack the problem of non-uniform risks? Flowers distinguished three sectors that must meet and decide such matters: the creators, the controllers, and the exposed. It was this last sector that received a degree of attention at this Conference that I have not previously observed.

Lord Ashby, Chairman of the Royal Commission on Environmental Pollution 1970-73, examined the broad question of risk identification and evaluation. He cited the economist's approach of assigning a dollar value to human life, but rejected it as "morally obscene." In doing so, he, early in the proceedings, adopted the theme which ran through the Conference—that the usual scientific dispassion is inappropriate for risk assessment, and a more humanitarian approach must be sought. He admonished scientists not to feel superior, noting that Room 13 in the Athenaeum Club (London) is, in fact, labeled Room 12A. He cited the apparent human irrationality in accepting an annual automobile death toll of 7000 persons in Britain with little reaction, contrasted with the vast concern over a rare 350-person aircraft accident.

Bryan Harvey, Chairman of the Advisory Committee on Major Hazards, spoke on "The Problems of Controlling Advanced Technologies by Legislative Process." He dismissed W.S. Gilbert's doctrine, "Let the punishment fit the crime," as grossly ineffective when applied to risks in technology. A culprit, if one can be found, will have little likelihood (or opportunity) to repeat his "crime." The logic of this position is generally popular with criminologists today, but the deterrent effects of punishment remain disputed. He noted a historical shift in law: in the 19th century, an employee accepted risk with the acceptance of employment; no longer does he.

Harvey listed five approaches to risk minimization and alleviation. (1) Insurance. Harvey finds little minimization through this approach. (2) Safety bargaining; see below, under the last paper. (3) Health and safety regulations. Objection: People just meet regulations and may actually dismiss safety concerns thereafter.

(4) Licensing. Harvey feels that this mainly transfers the risk from the doer to the licensor, with little actual progress. He also voiced a concern that establishing licensing agencies drains manpower from actual production and development, where they may be better used. (5) Self-licensing. This is Harvey's favorite. An overseeing body replaces the licensing body, with consideration of standards provided by the producer himself. The producers would be required to report, at each stage, how safety has been assessed.

F.R. Farmer, Safety Adviser to UKAEA, defended the cogency of risk probabilities as a basis for risk assessment, while stressing their inexactness. He stated a theme that apparently met with universal agreement: even if not all possible modes of accident can be discerned, optimal design based on known modes reduces risk through unknown modes.

Brigadier R.L. Allen, former Chief Inspector of Land Services Ammunition, delivered the most entertaining lecture, on "Some Lessons from Military Experience with Ammunition and Explosives." He acknowledged that risk assessment in the military differs from that in the civilian sector, particularly in open societies. Then he cited "advantages" of the military: (1) The mere name explosives invokes a sense of danger that galvanizes effort and support. (2) The military is unconstrained by "democratic nonsense." (3) Military safety has a long history that demonstrates that the goal of safety design is not to make systems foolproof, but idiotproof.

Allen drew his list of conclusions, humorous and serious. (1) There are many, probably infinitely many routes to disaster. (2) The Totalitarian Law of Physics holds: Everything that is not forbidden is compulsory; everything that can happen, will happen. (This was contested in discussion; the corrected restatement might be, given sufficient time, everything that can happen, will.) (3) Safety inspectors should be brought in from the very beginning; not only does this aid the safety assessment, but the inspector frequently can contribute to the planning and design as well. (4) The safety inspectorate must be completely independent of the producers, designers, etc. (5) Simple principles of safety should be met; dangerous products should be segregated, categorized, etc. (6) Finally, assume a disaster will eventually occur and design to constrain that disaster.

Professor G. Atherley, head of the Department of Safety and Hygiene, Univ. of Aston, the only academic safety department in the UK, proposed that the parlimentary (democratic) process is inadequate since political representatives are ill-informed and actually have little ability to influence progress on safety. His proposal calls for the establishment of community-risk advisors. He would have central government lay down broad rules, then leave it to industry and residents to define safety requirements, with the guidance of the community-risk advisor. Amazingly, he advocates that the advisor be given no compensation, be armed with little or no budget (industry could contribute the costs, for example, as a favor), and be given no executive power. Coming from a person involved in the education of safety technologists, these constraints leave me wondering whether they should be viewed as ridiculous or as refreshing.

Most of the Conference's material was not original. Indeed, it is difficult to see how vast amounts of originality can be brought into conferences on safety (or, many other technical matters). But it would be a mistake to dismiss the whole thing as fruitless. For one thing, there is a marked trend to recognize the advantages or necessity of bringing Mr. John Q. Public into the debate on safety and its subsequent enforcement. In public utterances at the Conference, it seemed to be a new creed; in private discussions, it was less popular. In any case, Mr. Public will increasingly frequently sit next to Prof. Big Science on such panels, and it is incumbent on each to learn to converse with the other.

This last conclusion holds if we adopt the assumption that Prof. Science belongs on such panels. This assumption, it seems, is adopted universally, too. What has not been answered, what this Conference should have addressed itself to and didn't, is what impact the scientist can have on such matters as safety, particularly in low-technology situations. The detailed, specialized information that scientists possess will have a minimal impact

on such situations. Is it scientific method and innate intelligence that forms the scientist's contribution? If so, is this the best application of his talents?

The Conference was characterized by a diffuseness that was inevitable, given its purpose—to survey alternative approaches and options. The report on "Superstar Technologies," by contrast, is a more logically directed, scholarly survey of the nature and hazards apparently inherent in technologies, particularly the very large ones. For example, the report lists the "frailties" that contribute to failure: inadequate experience, ignorance of technical literature, non-cooperation with other relevant experts, professional rigidity, neglect of safety precautions, commercial pressures, unwillingness to speak up, overconfidence, suppression of dissent, loyalty to an enterprise, and secrecy. Its conclusion is that these frailties can be countered only by explicitly subjecting technological development to open scrutiny. But how?

According to the report, the control of advanced technical projects on behalf of society must depend on the same principles as does science, and it therefore requires the strengthening of critical scrutiny inside and outside the corporate agencies of technical change. Again one must ask how? After surveying available monitoring schemes, the report concludes that the wide range of resources that may be needed to monitor a superstar technology at various stages of its history cannot be accommodated under one roof.

CSS makes one speculative recommendation: the formation of a Technical Implications Commission. This Commission would foster the discovery, assessment, and diffusion of reliable information about proposed advanced technical projects, so as to provide conditions for effective monitoring with appropriate public participation at all stages of development. It would seek information, issue public warnings, sponsor public debate, and publish confidential information. It would not become part of an advocacy procedure. Further details are not developed yet.

The CSS "Superstar Technology" report (£2 from CSS, 314 St. Andrews Hall, London EC4V 5BY) is only slightly more activist than its stated Council objectives: "...to help <u>others</u> (my emphasis) to work out the most appropriate solutions to these problems in the course of a responsible public debate, conducted at leisure on the best information available rather than by the hurried ill-informed and ill-considered process...." Whether such an approach contributes to the optimal development of technology is debatable and is being debated. (A. Sosin)

RESEARCH CLIMATE IN ITALY

In order to understand some of the difficulties encountered by some of the researchers in Italy, one should get a feeling for the prevailing climate in their universities; the reader should be cautioned that it is difficult in a visit lasting a few days to obtain a comprehensive view of this situation. Some of us who visited Italian universities in the north (*ESN* 31-6:229) have found that the university life proceeds in a normal way. This does not seem to be the case for Milano, Bologna and Rome. My visit was to the latter two, and this note attempts to summarize some of my impressions. The interested reader is referred also to an earlier article (*ESN* 30-4:155), to which part of this note might be considered a sequel.

Much of the present-day unrest in Italian universities stems from reforms introduced after the 1968 tensions in European universities. In 1972, as a result of such protests in Italy, universities opened their doors, and a free-enrollment policy allowed any student from the Italian high schools and trade schools to enter. The University of Rome, I was told, has about 150,000 students enrolled while only 30,000 attempt to attend classes. Nevertheless, the entire student body expects diplomas, which are supposed to be the tickets to employment and the good life. As a result, university diplomas have lost their former academic significance, and many graduates have joined the ranks of the unemployed.

This year, the Italian government is attempting to correct some of the shortcomings, more particularly the open enrollment, and bring the university system back to a state of affairs akin to that of the pre-1968 years. Such reforms have not been popular

with the students nor with some members of the staff.

In February, riots at the University of Bologna resulted in the death of a student, and the universities of Bologna and Rome closed their doors for a few weeks. Several university buildings were occupied by "Metropolitan Indians," a name now used to denote the more violent students who participate—sometimes very suddenly—in such occupations. Should a researcher not have good inside contacts among the Metropolitan Indians, he might find himself locked out of his office with no adequate notice, and his work might be stalled for weeks on end.

During my visit, riots erupted at the University of Rome. Provocateurs, a small number of students with political convictions on the far left, shot at the police. The toll was one dead and one severely wounded policemen. After having been opened for some 10 days, the University of Rome is again closed until further notice—probably until the end of May. Emotions run high, and the Italian government has decreed that from now on violence will be met with firearms.

From my conversations it appears that the universities visited are no longer what they used to be as far as research is concerned. If computer terminals were available outside of the universities, many researchers would probably work productively outside of the difficult university environment.

What about the government laboratories? In some there is too much "pull" involved in filling positions, and the qualifications needed for such positions are often disregarded. Party politics also plays a significant part in the research life of some establishments.

Utopian considerations often interfere with work. I was told that in one laboratory it was decided that the job of a telephone operator is a boring one. Thus the telephone operator ought to be relieved of such boredom and his or her job shared by everyone in the lab; each scientist should therefore man the switchboard for an hour or so. People are reluctant to establish differences in job positions and so all are made equal.

Once in a given position, a person has tenure for life. Italy is the country in which job insecurity is practically nonexistent. Unfortunately, many people are out to exploit such a system and advocate the *dolce far niente*. Yet, surprisingly enough, research money is available and adequate; also, the brain power is there! The existence of these two elements coupled with the administrative excesses and inertia gives one a sense of desperation that is shared by many of the Italian scientists I talked to, who look at the international scientific scene for hope and encouragement. Many try to spend extended periods of time in the US, where they enjoy the atmosphere in which research is carried out.

The University of Bologna boasts computer capabilities similar to those of the National Center for Atmospheric Research in Boulder, Colorado. Yet a scientist from Bologna goes to Boulder at regular intervals to carry out her research. On the other hand, a number of us (see ONRL Report C-37-76) have witnessed outstanding achievements by Italian scientists at conferences and technical meetings. The picture is therefore a complex one!

Recently Italy was given an IMF loan. When discussing it, an Italian scientist expressed indignation that Italians grumble at the IMF conditions, which are aimed at bringing down an inflation rate that now exceeds 20% per year. His attitude was that Italy should not be helped financially, especially by the US, so that the "boil" will erupt and make the Italians realize that they must face up to their problems. (Albert Barcilon)

MATERIALS SCIENCE

ACRONYMS, ANYONE? (AA)

You can't tell a player without a program, and you probably can't proceed too rapidly in following developments in science and technology without some familiarity with the multitude of acronyms that have been introduced to expedite(?) reading and discussion. This situation occurs in many fields of science, but it is particularly apparent in surface science. Below are listed 24 acronyms that were

used in a single conference on surface science I recently attended (see the following *ESN* article). Score 4 points for each one you identify; we'll give you 4 points to start with since (as far as we know) no one has acronymized ellipsometry, one of the tools of this trade. The answers are given after the next *ESN* (sic) article.

1. AES	13. LEED
2. ELS	14. RHEED
3. ERM	15. SAM
4. ESCA	16. SEM
5. EXAFS	17. SES
6. FDMS	18. SIMS
7. FIM	19. SLEED
8. IAP	20. TDMS
9. INS	21. TEM
10. IRM	22. THEED
11. ISS	23. UPS
12. ITD	24. XPS

(A. Sosin)

ISSC3—THE STATUS OF SURFACE SCIENCE

Surface science is considered by many to be the most rapidly burgeoning sector in materials science. There are a number of reasons for this rapid growth. The scientific purist would relate it to a previous unwarranted lack of emphasis on surfaces; in this view, surface science is "playing catch-up." A more jaundiced appraisal would attribute the boom to an attempt by scientists to jump on the "relevance" bandwagon. Surface reactions—catalysis comes to mind immediately—have been singled out as important, even crucial, and in need of development, particularly in the energy field. With "relevance" come financial support and, inevitably, scientists close behind—so this reading goes.

Still a third view of the new intensity of buzzing in the surface-science beehive relates to an amazing explosion in equipment capability. The quiz which is located in the article above serves as an indicator of this. Few of the techniques in this area were available until recently. Their sudden development follows directly from the microelectronic revolution now in progress, a concentrated attack by designers of particle-acceleration, focusing, and detecting systems, and high-vacuum technology development. In this scenario, the confluence of these separate threads has led to a stable of instruments of unparalleled resolution and image-reconstitution capability, and surface scientists are naturally taking advantage of developments.

All three interpretations found support in the papers offered at ISSC3—the Third International Surface Science Conference—held at the University of York, 27-30 March 1977. This is the second ISSC held there, and I would readily cast a vote to designate this University as the permanent site for ISSCs. Few campuses could compete with the beauty and intimacy afforded by this University, which is built around an artificial lake, with the Physics Department (where meetings and poster sessions were held), dining, and living areas closely and pleasantly dispersed about its periphery—even in the grip of the snow and cold winds that prevailed on this occasion. And the walled city of York, close by, affords an unparalleled view of Roman England.

Over 20 nations were represented at the Conference, and attendance numbered 244, including 125 from the UK, 27 from France, 25 from West Germany, and 8 from the US. In comparison, ISSC2, held at the University of Warwick in 1975, attracted 300 people. Some of the fundamentals of several surface science techniques, particularly AES (for the description of all acronyms herein, see the quiz above and answers below), ESCA, and SIMS, were presented in a report of that meeting (see *ESN* 29-5:233).

ISSC3 opened with papers that pointed toward technological relevance. J.E. Castle (Univ. of Surrey), in an invited talk, concentrated on the use of XPS to study the thin surface films that are the core subject of corrosion science. XPS, probing to a limited but significant depth, with both elemental and valence-state analysis, lends itself well to corrosion studies. Castle presented the interesting comparison of oxide formation on Ni_xCu_{1-x} alloys where the oxide structures are highly sensitive to composition and temperature. He also noted the variance in Fe valence state in oxides on steel, depending on Cr content. Too briefly, he mentioned work in his laboratory on the corrosion of brass tubing in the field and the

study of corrosion in nuclear heat exchangers and dental amalgams.

The most application-oriented use of XPS was presented by W.J. van Ooij (Alzo Research Laboratories, Arnhem, the Netherlands). The practical problem is the adhesion of rubber to metal in steel-belted tires. To obtain this adhesion, the steel is generally brass-coated, a task which is not easy nor fully reproducible. In order to understand this adhesion—rubber to brass—van Ooij formed brass-rubber-brass sandwiches by heating at temperatures up to 475°C. The rubber is vulcanized in the process. The brass is then peeled cleanly from the rubber in liquid nitrogen. Van Ooij's finding is that ±½% Zn has profound effects in determining the extent of Cu_2S formed in the interface; Cu_2S plays an essential role in determining the bonding between brass and rubber. The fundamentals of this phenomenon are obscure; van Ooij says this still is true of much of rubber chemistry. Nevertheless, he has apparently developed XPS into an indicative tool for tire-belt bonding.

The first session—of eleven papers, not including the poster session—was completed with a discussion of ESCA (essentially the same as XPS!) measurements of oxide layers on Cr-bearing alloys. With the exception of a somewhat unconvincing reference to the role of surface science in the technology of catalysis in a subsequent invited paper by H.P. Bonzel (Kernforschungsanlage, Jülich), I noted no other discussions of "relevance" in the Conference. My conclusion is that the boom in surface science is loosely coupled, at most, to considerations of "relevance," as reported in the Conference papers. One wonders whether the initial proposals for financial support bear a similar relation to "relevance."

Then the question becomes: what is the status of the science being explored? Here the reader is urged to form his own evaluation by reading the Conference proceedings when they appear in the journal *Surface Science*. One indicator might be the invited paper of J. Jona (SUNY, Stony Brook), who presented an excellent report on LEED crystallography, complete with atom-packing models that follow from the two-dimensional surface-diffraction patterns. Jona's examples and several papers, both oral and poster, give firm evidence of LEED's ability to provide such neat patterns for a variety of surfaces and adherents. But the implications of these patterns is apparently largely a matter for tomorrow; they were little discussed at the Conference.

Perhaps one should look to the theoreticians for "the next step." A.R. Williams (IBM, Yorktown Heights) reported impressive exact numerical solutions for atomic chemisorption on simple metals. The power of calculations using available computer techniques is clear; the generalizations to be drawn are more obscure. Model calculations by N. García (Univ. of Madrid) on scattering of atoms from "a corrugated wall" offer little illumination for experimenters at this stage of development.

Adsorption or chemisorption of various species on a variety of surfaces was the basis of a large number of papers: Sn on Cu (LEED); ethylene and acetylene on ion-exchanged zeolites (INS); H_2 and H_2O on Pt (INS); O_2 on several metals and oxides (SIMS); CO on Ni, W, and Fe (SIMS); Ag on Si (AES); Cs on Si (LEED); Zn on GaAs (TDMS, SEM, AES,and RHEED); O_2 on Al (XPS, AES)—these are but a selected subset of the examples presented. While surface science provides the rationale for the studies, equipment considerations are very prominent, as evidenced by remarks of some contributors: "The value, and perhaps the necessity, of employing a wide range of techniques to investigate metal-semiconductor systems is clearly demonstrated." "An explanation is suggested why previous work with AES and CO chemisorption did not reveal any surface enrichment." "Further improvements in the understanding...can be expected from SIMS with other quantitative surface-analytical techniques."

The status of surface science seems to be transitional. Considering the amount of work underway, one might regard the current rate of progress as disappointing. But this evaluation would probably misread or neglect the instrumental preparations the field is experiencing. The situation might be compared to an army which is being equipped with an arsenal of new, powerful weapons. Battles are not won at this stage. Scientific knowledge—at least, scientific insight—is moving ahead slowly now, perhaps. But momentous events may be in the offing.
(A. Sosin)

ALL ACRONYMS ANSWERED (AAA)

1. Auger electron spectroscopy
2. Electron (energy) loss spectroscopy
3. Evaporation rate monitoring
4. Electron spectroscopy for chemical analysis
5. Extended x-ray absorption fine structure
6. Flash desorption mass spectrometry
7. Field ionization microscopy
8. Imaging atom probe
9. Inelastic neutron scattering
10. Ion rate monitoring
11. Ion scattering spectrometry
12. Isothermal desorption spectrometry
13. Low energy electron diffraction
14. Reflection high energy electron diffraction
15. Scanning auger microscopy
16. Scanning electron microscopy
17. Secondary electron spectroscopy
18. Secondary ion mass spectrometry
19. Spin-polarized low energy electron diffraction
20. Thermal desorption mass spectrometry
21. Transmission electron microscopy
22. Transmission high energy electron diffraction
23. Ultraviolet photoelectron spectroscopy
24. X-ray photoelectron spectroscopy

AS (PhB, BS, MS, PhD)—ONRL

DIFFUSE X-RAY SCATTERING AT JÜLICH: A MAJOR CAMPAIGN AGAINST INTERSTITIALS

The moral of this report is that sometimes it takes a cannon to kill a flea. (N.B.: the cannon in this tale is very sophisticated, indeed.)

As the study of lattice defects in crystalline materials (specialized in this report to metals) has matured, so too have the techniques used by investigators. The use of diffuse x-ray scattering (DXS) at the Institut für Festkörperforschung, Jülich, FRG, is a particularly impressive example of assembling a major experimental capability (and understanding) to attack a set of problems in the physics of the defect solid state. There is also a lesson to be drawn from this effort, which is offered at the conclusion of this report.

The eventual goal of defect physics—the study of lattice defects in solid materials—is a complete characterization of defects. It might be divided into three aspects. One is the study of the nature of the defects. For example, the characterization of a vacancy in a metal would include the lattice relaxations in the vicinity of the missing atom; i.e., the positions of the atoms neighboring the vacancy and extending to as many further positions as seems necessary. This aspect might be called the static properties of a defect, a title that would not be fully accurate since lattice vibrations, altered by the presence of defects, are also of interest.

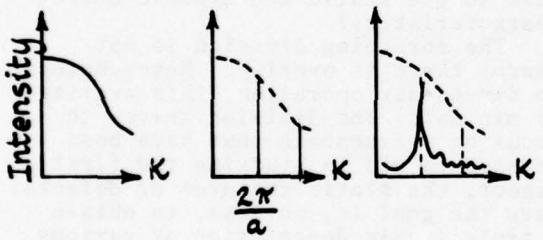
The second aspect concerns the dynamic characteristics of defects, particularly their diffusion and their interactions with one another. In principle, these two aspects are based on the third, which is founded on the question: What are the interatomic potentials (and related basics, such as electron distributions) that give rise to the static and dynamic defect characteristics?

The foregoing division is not sharp; there is overlap. Nevertheless, in day-to-day operation, this overlap is minimal. The division serves to focus on refinements that have been devised to aid in studying the first aspect, the static features of defects. Here the goal is, no less, to obtain a truly atomic description of various defects. Although more than one technique now approaches this goal, DXS is a particularly powerful tool for investigating interstitial defects.

The use of x-ray techniques for the study of "perfect" crystal lattices is of long standing; their use for defects is more recent but is no longer new. DXS is, however, a major departure from such x-ray techniques and might also be considered as a combination of these. An impressive feature of DXS is its very conception, considering its character and unusually sophisticated physical basis. The other almost overwhelming feature of DXS, to which I return below, is its experimental architecture.

The scattering of x-rays from an isolated atom (in free space), follows a familiar pattern in both configuration (e.g., ordinary) space and in momentum space (more commonly converted to K-space, where K is $1/\hbar$

times the momentum of the x-ray photons). The intensity of scattering falls off monotonically from a maximum at $K = 0$ (i.e., no scattering of the photon by the atom). In a truly perfect crystal (in the absence of lattice vibrations), the intensity of scattering in K-space consists of zero-width peaks at Bragg vectors with $K = n(2\pi/a)$, where n is an integer and a is a lattice distance (a distance between atoms). The heights of these peaks are predicted by the curve for the isolated-atom scattering case; between peaks there is nothing—nothing, except when defects are present (i.e., always). Then there is, indeed, structure between the Bragg peaks. It is a very weak and a generally dismissed structure; see the figure, in which the structure is greatly exaggerated. Experimenters have concentrated on the peaks (Bragg scattering) or the region very close to the peaks (Huang scattering).



Intensity of x-ray scattering as a function of K-vector by (left to right) an isolated atom, a perfect, static crystal, and a real crystal, possessing lattice defects

In the very low intensity "noise" between the peaks, however, there may be a veritable mine of information about the defects in the lattice. The reason the information is stored there is related to the reason the intensity would be zero, in theory, if there were no defects. The perfect cancellation of scattered waves by lattice planes is violated by the distortions created by the defects in the lattice planes. Each defect possesses its own distortion signature; conversely, by reading the signatures, one should be able to deduce the nature of the defect; i.e., the lattice distortions created by the defect. This analysis is not straight-forward; the services of a capable analyst to develop scattering intensities as a function of lattice directions is quite essential. In the studies at Jülich, in the hands of H.-G. Haubold, the observed scattering intensities are compared with calculated intensities. The match that has been obtained between observation and calculation for one particular self-interstitial defect configuration in aluminum and the mismatch in this comparison with alternatively hypothesized configurations is very impressive.

The catch in all of this is that there is additional background scattering that masks the details being sought. Most of this competition is due to Compton-scattering (i.e., non-lattice scattering). For 500-ppm interstitials, Compton-scattering is up to 100 times the defect-scattering intensity. Increase of the defect concentration is proscribed by the agglomeration of defects which begins to set in. In addition, measuring times in x-ray studies of background scattering are generally long.

Haubold has surmounted these difficulties by assembling apparatus that reduces the measuring time to 10^{-4} of previous times (and, with it, increases the discrimination of the defect-scattering signal from the Compton-scattering) over conventional apparatus. A factor of 10^2 comes from the use of a 100-kW rotating-anode x-ray tube in place of the conventional 1-kW tube. The second factor of 10^2 comes with the use of 100 Si(Li) detectors instead of 1. These detectors are arranged on a focusing circle and feed the data into an on-line data-processing system. Adding to these major experimental increments in equipment complexity, Haubold usually performs measurements at 4 K (to avoid defect diffusion, agglomeration, annihilation, etc.). Highly accurate cross-sectional measurements are obtained by a differential technique, using a reference sample essentially devoid of all defects.

The size and complexity of the apparatus and the scope of the program may be appreciated from the foregoing description; the true competence of the investigators is appreciated only by visiting the laboratory.

The applications of DXS, to date, have been heavily concentrated on the analysis of self-interstitials, and this work is far from complete. Nevertheless, DXS is also powerful in analyzing other defect configurations. Small defect clusters or second-phase precipitates are amenable to characterization, and they possess a basic importance in metallurgy and much of materials science.

Will there be a DXS apparatus in every laboratory that studies defects in metals in the future? Should there be? To this reviewer, the answer is "no" to each question. Obviously the apparatus is costly. More importantly, the scale of the project is so large that it seems natural, if not inevitable, to restrict the number of such facilities.

If these deductions are correct, W. Schilling and his co-workers in the Jülich Defect Physics Group have demonstrated that large, costly, complex apparatus and supporting personnel are a natural province for national laboratories. Indeed, one could argue that complex and costly facilities should be located in national laboratories, and that less demanding experimental apparatus should belong to universities, with the proviso that university investigators obtain access to national laboratories' special facilities. The argument is neither new, nor accepted. What is clear is that the Defect Physics Group under Schilling has gained worldwide pre-eminence in its field by striking out along difficult but vital directions, then pursuing these directions with complete determination and great skill.
(A. Sosin)

OCEAN SCIENCE & TECHNOLOGY

ELECTRONICS IN THE FISH INDUSTRY

On 3 May the Aerospace, Maritime and Military Systems Group of the British Institution of Electronic and Radio Engineers held a colloquium on Fish Industry Electronics at the Royal Institution. The meeting was undoubtedly intended to draw the attention of the British electronics community to the growing opportunities for research, development, and sales in the fish industry taken to include fishing, processing and marketing.

Although very much a British colloquium, with all ten contributed papers and almost all the 40 participants being from the UK, many of the comments and points made were of wider interest.

To this observer who is not immeshed in the fishing industry, the colloquium highlighted the rapidly changing situation brought about particularly by the new 200-mile limit, by changes in fish populations which require the British and others to place emphasis on pelagic shoaling fish, and by the substantial rise in fuel and labor costs.

Traditional electronic contributions to the industry have included navigation and communication systems, echo sounders, and fish-location sonars. The growing opportunities for the electronics community now include a response to requirements for a high level of automation and associated control devices, in both the fishing and processing phases of the industry. At sea there is also need for tactical displays ranging from simple surface navigation plots of own ship relative to other vessels, to coverage of the fishing operation itself in both the horizontal and vertical since the net must be at the shoal depth. Above all integrated displays are required that will obviate the need for reference to the outputs of individual devices, which currently threaten to turn the "one-man band" skipper's bridge into an aircraft pilot's nightmare.

Although only briefly mentioned, there are clearly additional opportunities for innovation in the difficult field of estimation and monitoring of fish stocks on a geographical basis, and this calls for further development of fish target-classification techniques.

Dr. R. Bennett [Industrial Development Unit, White Fish Authority (WFA)], in his introduction to the colloquium, took the opportunity to correct possible impressions that the industry was declining, which he felt may have arisen from press reports of the impact of fuel costs, the British-Icelandic "cod-war," and fish quotas. He stated that in fact there had been no significant reduction in

the catch. Further, while there might be a decline in long-distance fishing, he predicted that the 200-mile zone would result in prosperity for near-shore fishing with 1.5 million tons a year as a future UK target. Changes in the available fish-species mix require increased emphasis on pelagic shoaling fish such as mackerel. He predicted a vessel size of 90-120 ft capable of operating in all but the very worst weather, with sophisticated electronic equipment costing 5, 6 or possibly 10% of the total ship cost of £600,000 to £1,300,000. In his view deep-shoaling species would be a difficult target from a moving platform, and he noted deficiencies in some vertical echo sounders that arise from poor target echoes, either because of the considerable target depth or low target strength as in the case of squid. Whereas filleting of fish had previously been manual, increasing exploitation of smaller pelagic shoaling fish; e.g., the blue whiting weighing about ¼ lb, would necessitate increased automation and the use of electronic sensors rather than the current mechanical systems.

While these changes are coming at a financially difficult time, Bennett considers there are brighter aspects and cited new fisheries, such as the blue whiting, which have been brought about by government research and development covering all aspects of the subject through to marketing. Internationally, with the 200-mile limit a legal entity, indigenous fisheries will expand and there will be substantial prospects for the worldwide sale of equipment, although this will be limited by training requirements. In his view the real plums will go to the suppliers of simple, rugged equipment who are willing and able to provide adequate personnel for training. Bennett concluded by reemphasizing the importance for the future of small shoaling fish, the marketing of an edible product, and electronic automation.

Dr. F. Harden Jones [Directorate of Fisheries Research, Ministry of Agriculture, Food and Fisheries (MAFF)], in an excellent talk entitled "Fish-Availability, Accessibility and Vulnerability," stressed the importance of catch per effort. He noted that, while the fisherman is primarily interested in the catch, the manager is equally concerned with what has been left behind. Knowledge of the availability of fish requires understanding of the movement and levels of fish stocks, and methods for their assessment. Factors such as bottom topography, temperature gradients that limit detection, and the like determine the accessibility of the available fish to a particular net in a given position. "Vulnerability" is concerned with the direct interaction between the fish and the gear, or the proportion of accessible fish caught. Jones noted the value to MAFF's vulnerability studies of a 300-kHz sector-scanning sonar developed more than a decade ago by G. Vogliss of the Admiralty Research Laboratory, Teddington. With this system installed aboard a research vessel, it was possible to follow a fish tagged with a small acoustic transponder against the bottom-reverberation background and simultaneously monitor the trawling operation conducted from a second ship. Repeated operations of this type permitted an analysis of efficiency as a function of fish position relative to the net opening. This technique can also be used to study different net configurations.

The following contribution from the firm of Kelvin Hughes (Ilford, Essex) described their situation-display radar. In addition to the usual navigation arguments for such a display showing the behavior of other vessels in close proximity to one's own ship, there was the argument that one can assess from another ship's behavior whether it is in an area of heavy fish concentration. A second specific commercial development of a system for the electronic control of hydraulic winches due to Bell Electronics (Bracknell) working in conjunction with the Norwegian company Hydraulick Brattvaag (Brattvåg) was then described. This system depends on maintaining an appropriate tension in the warp wires. It can be used for automatic operation, including payout and recovery. Automatic operation assists in maintaining a constant speed of the net over the bottom in rough weather, and provides protection by paying out in the event of snagging of the gear. A second system incorporates the use of the signal from fish-finding equipment as a net-depth control.

F.J. Nicholson (Torry Research Station, MAFF) then outlined progress made in the Station's fish-processing-machine program aimed at species

sorting, size grading, and the radial and axial orientation of round fish. Preliminary investigations have not demonstrated reliable species sorting, but grading and orientation machinery have been developed having a potential use with gutting machines in automatic-processing lines. Early work emphasized mechanical systems, but these were relatively large and slow—particularly for shipboard use. While these endeavors have continued, some effort has been switched to the possibilities of electronic measurement and control. The design and development of fish processing machinery are currently underway using opto-electronic and integrated-circuit logic to measure fish length and to control cutters and brushes.

A paper by J.A. Tvedt (British United Trawlers Ltd., Hull) expanded the points made earlier by Bennett as to the current and future use of electronics in fishing. Tvedt, a naval architect, emphasized the requirements for (1) safe and quick navigation on the fishing ground, (2) sufficient information on the location of the fishing gear at all times and on the fish during trawling and purse-seining operations. He noted that there is an increasing amount of electronically generated information aboard fishing vessels and that its volume is almost independent of ship size for ships longer than 85 ft. This increase, he believes, is partially due to improvements in equipment displays and reliability accompanying the use of solid state devices. Radar tends to be of simple types. Decca and Loran C navigation systems are widely used when available. The 200-mile limit brings a need for developing new fishing grounds, and although Omega would provide navigational coverage of most areas of concern to the UK, it would not be sufficiently accurate and there would also be a requirement for satellite navigation systems. Radio facilities on fishing vessels are often much better than in merchant ships of substantially larger size.

After briefly outlining advances in the acoustic detection of fish and shoals, Tvedt described the Norwegian Simrad position plot as one of the most notable developments in the seventies and Japanese developments in color presentations as another. (The Simrad CD Sonar Situation Display combines the developing fishing information concerning the target and own ship in a tactical plot relative to own ship position, or shows true motion relative to the shoal.)

For the immediate future, Tvedt emphasized the need to concentrate information about the fishing operation in one unified display near the radar. Beyond this he stressed the need for improvement in the quality of instrumentation instruction manuals and recognition that they must meet the needs of the skipper.

Later contributions included a discussion by E. Allison (WFA) of the Authority's instrumentation of trawlers designed to obtain quantitative engineering information on the overall performance of a vessel and its fishing gear. Incorporated are measurements of propeller-shaft torque and thrust, tension in tow wires, engine and winch parameters, and information on the trawl itself, including its opening configuration, towing speed and direction, and water temperature.

In another paper Dr. P.A.M. Stewart (Marine Laboratory, Dept. of Agriculture and Fisheries for Scotland) reviewed work on marine electrical fishing using electrotaxis (compulsive swimming toward the anode) and electronarcosis (stunning). He noted the impact of improved techniques for investigating fish behavior, and the simplification of equipment resulting from the use of semiconductor technology. UK work has been restricted to low-voltage systems with attention to the problems inherent in their mounting on otter trawls. The cost of power cabling, which may need constant-tension winching, is recognized as a potential problem. The aim in much of this work is to use "electric tickling" as a means of inducing burrowing fish and shellfish to leave the bottom. The current practice of towing heavy chains along the bottom for this purpose causes considerable disturbance and damage.

Returning to the processing and marketing phase of the industry, Dr. J.C.S. Richards (Univ. of Aberdeen) reviewed the development of an electronic fish-freshness meter based on the measurement of power factor, with the fish used as the dielectric in a capacitor. This device is now being marketed by G.R. International Electronics Ltd., Perth. To overcome

polarization effects, the instrument, which operates at 2 kHz, employs a four-terminal electrode system, two electrodes feeding alternating current through the specimen and the other two measuring the potential difference. The instrument's power-factor measurement is self-compensated for temperature and provides a freshness scale directly related to sensory assessments [*J. Phys. E* 8, 826-30 (1975)].

In the final paper Dr. M. Kent (TRS, MAFF) discussed the potential use of microwaves and especially their possible application in the field of moisture measurement.

All in all, the contributions to this colloquium were a very mixed bag. With few exceptions they tended to be individual rather than being designed to present the subject as a whole. At best they were representative of the field. At least one contribution had been prepared on very short notice. The authors of two others could not be present, and their papers were read. Not a good start, particularly when taken together with the small attendance. Nevertheless, the message was clear. Many factors have contributed to the substantial changes occurring in the UK fish industry and, indeed, to the industry generally. They include labor and fuel costs; fish availability and non-availability in terms of species, stocks, and distribution; and, not least, the 200-mile limit, which forces attention to new fishing grounds, species, and techniques. These changes offer substantial opportunities for greater application of electronic technology, much of which may be applied almost directly from other areas, or with minor adaptation. (A.W. Pryce)

THE INSTITUTE FOR SHIPBUILDING OF THE UNIVERSITY OF HAMBURG AND THE HAMBURG SHIP MODEL BASIN

The Institut für Schiffbau (IfS) of the University of Hamburg and the Hamburgische Schiffbau Versuchsanstalt (HSVA) comprise one of the major naval architectural research centers in the world. Though first established in 1913 as the then largest and most modern model basin, the original site of the HSVA was abandoned in 1945 and facilities were built at a new location starting in 1953. At the present time, the HSVA is again one of the largest and best-equipped model basins. It is a private, non-profit company sponsored jointly by 28 shipowners and shipyards. Among its clients are shipowners, shipyards, navies, oil companies, national agencies, and research institutes from all over the world.

The IfS celebrates its twenty-fifth anniversary this June. The Institute comprises some 60 staff members, of whom 25 are scientists including 4 professors from the Technical University of Hannover. Some 45 students are enrolled at the Institute. The library consists of 5000 books, 5000 bound volumes of periodicals, 8000 reports from various countries, and 150 active subscriptions to publications. It has exchange agreements with the other most important relevant centers. Because the IfS will be covered separately in connection with its 25th Anniversary Colloquium, only the work in common with the HSVA will be discussed here.

My tour of the HSVA was conducted by Profs. O. Krappinger and K. Wieghardt along with Dr. S.D. Sharma and Ober-Ing. H.P. Rader.

The large towing tank of the HSVA is 300 m long, 18 m wide, and 6 m deep. The maximum towing speed is 8 m/sec. The towing carriage is equipped with a computer for automatically controlling the experiments as well as data acquisition and reduction. For routine tests, the data are immediately converted to full scale and printed. A wave generator can supply regular waves of 0.4-m height and irregular waves of 0.7-m height that traverse the tank. Hull models exceeding 8 m in length can be tested in either towed or self-propelled mode in calm water for resistance and propulsion characteristics, or in rough water for seakeeping characteristics. The spectrum of the waves can be chosen to correspond to specific sea zones and weather conditions. Besides the testing of floating and submerged hull shapes, the HSVA has recently undertaken to study the characteristics of offshore structures such as fixed and floating platforms and moving systems along with the determination of response characteristics of positioning systems and the dynamic simulation of ropes or hoses.

Because it is very wide, the large towing tank is used for maneuvering tests of models for proposed vessels. The maneuvers are in the form of zigzag or spiral paths executed either in the towing or the self-propelled tracking mode. The steering and course-keeping properties of the model are evaluated in order that deficiencies in the design of a vessel may be remedied at an early stage. To facilitate the maneuvering tests, a Computerized Planar Motion Carriage (CPMC) was installed in 1975. The CPMC is less massive than the main towing carriage and is programmed to bring the model through a series of maneuvers; in the demonstration test that I saw, sensors on the CPMC caused it to follow the model in the self-propelled tracking mode so closely that it seemed to be towed.

The large towing tank is particularly suitable for testing models of tanker and cargo ships and is used extensively for that purpose.

In addition to the large towing tank, there is a smaller one of 80-m length, 5-m width, and 3-m depth with a maximum towing speed of 3.6 m/sec. The small tank is also equipped with a wave generator that can achieve a maximum wave height of 0.3 m. Since the small tank leads, at one end, to a circular basin 25 m in diameter, models of canals, harbors, junctions, and building ways with adjacent structures have been constructed in the facility to study the propagation and effects of waves, and to optimize the design and siting of relevant hydraulic structures.

The HSVA has a unique facility for testing models in ice that consists of a towing tank 37 m long, 6 m wide and 1.2 m deep; the tank has an automated freezing system that can keep a uniform temperature (within 1°C over a range of -20° to 0°C) to produce a sheet of ice of uniform thickness over the tank within a thickness variation of 0.5 mm. The freezing rate in the tank is 60 mm/day. A research program at the HSVA investigated the relationship between flexural strength, elasticity, salinity, and temperature for ice in order to produce a model ice whose properties would scale to the prototype situation.

The ice tank is used in tests of icebreakers, and two types of breakers are being studied. The usual icebreaker rides up on the ice; the weight of the vessel, transmitted through its specially reinforced keel, splits the ice and permits the breaker to plow on. The more elegant form of icebreaker under study had a squared-off bow and a flat bottom under the bow; as this breaker rides up on the ice, the ice is split on each side of the vessel and the submerged segment of ice under the bow is split by the keel further aft on the vessel. Water jets from the vessel wash the resulting ice fragments under the sides of the channel thus formed, leaving it cleared of ice fragments. The water jets may be supplied by a pair of Voith-Schneider propellers that also serve to propel the craft. Besides testing ice-going ships, the ice towing-tank investigates and optimizes fixed and floating offshore structures designed to operate in ice.

The last laboratory that I visited at the HSVA was the cavitation tunnel facility, which comprises 3 tunnels. The large tunnel has a 0.75-m-dia. test section with a maximum water speed of 19.5 m/sec; the intermediate tunnel has a 0.57-m square test section and a maximum speed of 10 m/sec, while the small tunnel has a 0.4-m square test section and a maximum speed of 7.5 m/sec. Cavitation occurs in flow fields where regions of low pressure (and consequently high velocity) exist. If the pressure drops below the vapor pressure of the working liquid, it will flash into vapor and bubbles or cavities will form in the flowing liquid. When the bubbles move into a region of the flow where the pressure exceeds the vapor pressure, the vapor in the cavities returns to the liquid phase and the cavities collapse, generating high-pressure pulses of magnitude 4×10^5 atm and concomitant noise. Propellers, their associated cavitation characteristics, and noise are being studied and propeller designs optimized. It is clear that, in order to inhibit tip cavitation, the blade loading at the tip must be reduced. Since in the process, the propeller efficiency is compromised, some intermediate solution between optimum efficiency and cavitation-resisting characteristics is found. Cavitation produces material erosion when the cavities collapse near a material boundary; thus the noise from collapsing cavities is not the only detrimental effect of cavitation.

The cavitation tunnels are also used to study propellers in inclined flow, cavitation on appendages, rudders, hydrofoils, sonar domes, and the like. The objective of such studies is to minimize the adverse effects of cavitation along with the corresponding losses in efficiency due to their cure.

In a demonstration a propeller viewed stroboscopically showed the cavitating blade tip and root vortices. In addition, some distance downstream from the propeller, a helical instability of the entire swirling propeller jet could be observed.

Besides model tests, the HSVA conducts full-scale tests in trials at sea to determine the actual performance of ships and to improve the interpretation of model data. (Martin Lessen)

PHYSICS

BRIGHTER HOLOGRAPHIC IMAGES AT LOUGHBOROUGH

I visited the Physics Department at Loughborough University of Technology to look at their optics work. Their thin-film effort was described in an earlier article (*ESN* 29-11:483), and the Human Sciences Department was described recently in *ESN* 30-7:330.

Loughborough is located in Leicestershire, 111 miles north of London, between Nottingham and Leicester. The University has several new buildings, and the Physics Department shares one of these with other departments. The former has large well-equipped laboratories and space for expansion. In fact, this Department is one of the few in the UK that are expanding rather than contracting.

Professor John Raffle, the Department Head, gave me an overview of the instructional aspects and the various research projects currently going on. This Department is one of the few that have a strong liaison with industry. Four-year honours-degree courses are offered in which the students spend one year of the four working in industry or government laboratories and then return to finish their academic work. Courses (i.e., specializations) are offered in physics, engineering physics, physics and education, and electronic engineering and physics. After satisfactory completion of a course, the students receive a BSc (Honours) degree as well as a Diploma in Industrial Studies (DIS). One exception is the physics-and-education course, for which a Certificate of Education is granted rather than a DIS. Most of the organizations providing the industrial training are in the UK; however, six overseas concerns are involved, including technical universities at Twente, Holland, and Lausanne, Switzerland.

Raffle explained that the research is subdivided into six areas. Graduate degrees (MSc and PhD) are conferred after satisfactory completion of research in any of the following subjects: mechanics of materials, optics, magnetic materials, plasma and gas discharges, surface physics, and low-temperature physics.

Raffle escorted me through the various laboratories. I will briefly describe the optical activities I saw and later discuss some of the nonoptical work.

Mr. Nick Phillips, a senior lecturer, has made important advances in the field of holography. He has developed a process for treating exposed plates which he claims results in a significant increase in the brightness of reconstructed holograms. Phillips and his assistant, Dave Porter, have been working with the commercial firm of Agfa Gevaert (GB), Ltd. to bring about this result. They feel they have an edge in performance over others working in this field. Understandably Phillips was reluctant to divulge exact details of the improved process since proprietary commercial techniques and materials are involved. He did say, however, that the major improvement was in the "chemistry" of the process and, in particular, the extremely important bleaching process. Phillips and Porter had already made earlier advances in processing holograms as described in their publication, "An advance in the processing of holograms," N.J. Phillips and D. Porter, *Journal of Physics E* **9**, 634 (1976).

The choice of photographic film affects both brightness and resolution. A compromise has to be made between coarse grain with bright images and

fine grain with dim images. US workers generally use Kodak emulsions such as 649F or 120-02. Phillips and Porter are working with Agfa Gevaert emulsions and are using phase holograms as opposed to the amplitude type. The latter hologram contains information in the form of light and dark fringes while a phase hologram contains information in the variations in thickness of the exposed emulsion. The phase holograms produced by this group have the low noise and scattering generally associated previously only with amplitude holograms. I was shown large holograms—up to about 2 ft x 2 ft—illuminated with 50 mW of radiation from an argon laser. The images appeared bright even in a partially lighted room.

Holograms developed by this group were featured recently in an optical show called the "Light Fantastic" at the Royal Academy (of art) in London. Crowds waited over three hours in very long queues to see the show. Phillips is taking on the task now of producing a full man-sized projected image. Also he is going to do some pulsed holography by using a 10-J ruby laser operating in a single mode with a Gaussian beam profile. Plans call for an increase in the output to 40 J in the future.

Holography is also being used as a tool by Dr. J.M. Walls of the Physics Department in collaboration with Dr. D.M. Rowley of the Mechanical Engineering Department and Dr. M.H. Unsworth from the School of Agriculture, University of Nottingham. They are studying how drops from sprays behave as they approach surfaces with the technique. From the holograms, they get drop-size distributions close to and at the surface.

Dr. David Emmony is investigating the interaction of laser radiation with the surfaces of solids and liquids. He is using various transversely excited atmospheric-pressure (TEA) lasers as sources of energetic radiation pulses. The resulting damage characteristics of Ge optical elements have been examined. He finds damage often forms in concentric circles on the surface. The explanation is that small surface particles or imperfections scatter radiation in a surface wave which interferes with the incoming plane wave, resulting in concentric interference fringes on the surface. Emmony is also looking at plumes and shock waves developed when laser pulses strike liquid surfaces. The propagation of acoustic energy from laser-induced shock waves provides a way of studying dynamic strain in solids. Emmony is using interferometric methods to measure the strain. Raffle feels that these kinds of studies provide an important and worthwhile link between laser people and mechanical people.

I spoke with Dr. R.P. Howson about his optical thin-film work. He reviewed his past work on electroreflectance of films which he has been pursuing for several years. This work was described in great detail in a recent article (*ESN* 29-11:483). As has happened to many scientists recently, pressure to move into energy-related studies has influenced Howson's work. He has recently completed negotiations with the European Economic Council (EEC), which will fund his studies of selective coatings applied to glass or plastic window materials.

These selective surfaces will have high transmittance, and therefore low reflectance, in the visible region of the solar spectrum but will strongly reflect infrared energy. A sharp transition between these two reflectivity extremes occurs in the near infrared. In this manner visible radiant energy from the sun is easily transmitted into a building while thermal energy in the form of long-wave infrared radiation into which the visible radiation is converted is trapped inside the structure. This is the same requirement that an efficient solar collector panel must have. For this application, the economics of applying the coating to large surfaces is quite important. The techniques for making exotic "optical" coatings usually used for laser mirrors, small windows, and other small optical elements would not generally be suitable for this project.

Howson is particularly interested in metal-oxide films such as tin oxide that have the necessary optical properties and also form durable films. He plans to deposit tin by thermal deposition in an oxygen atmosphere while a discharge is simultaneously occurring in the oxygen. Howson feels that this process, which does not require an ultra-low-vacuum environment, could be suitable for the fast, inexpensive coating of large windows.

Two laboratories are concerned with the determination of material

properties at high rates of strain. One lab had several different kinds of "hammers" driven by various methods such as: a cylinder driven by a pressure of 1 atm resulting from the sudden release of a vacuum, or high pressure released by the rupture of a membrane, and a pellet from an air rifle. Another experimental set-up used exploding wires in hollow cylinders.

Susceptibility and structure studies of magnetic materials are being conducted on rare-earth alloys. Thermal-conductivity studies at low temperatures (to 4 K) are being carried out on various materials. In the area of plasmas and gas discharge, research on wave propagation in quiescent plasmas and on the lifetimes of fluorescent lamps is being pursued.

Raffle finds time to do some research as well as running the Department. His recent work has been on detailed studies of hydration during the settling of cement suspensions in columns. His method, an improvement over the older technique of monitoring the settling velocity of the upper interface, involves measuring the excess hydrostatic pressure at various depths. These measurements permit the determination of details of interparticle reactions, base and wall stresses, rates of hydration reactions, and the variation of the permeability with time.

Loughborough's Physics Department, under Raffle's leadership, is producing graduates well trained in applied physics who will fill a need, mainly in industry, for people with an inventive approach to problem solving—a need which, according to Raffle, most engineers would not be able to fulfill. In addition, the quality of research in the Department is of a high level and the research staff is productive in their various areas.
(Vern N. Smiley)

LASER SPECTROSCOPY AT THE UNIVERSITY OF SUSSEX

The University of Sussex is located in Falmer on 200 acres of trees and green rolling hills in the South Downs, 4 miles northeast of the coastal resort town of Brighton. Although the University is relatively new, having opened its doors in 1961, it is now among the top three in the UK with respect to funding received from the Science Research Council (SRC). It is also behind only Oxford and Cambridge in members of the Royal Society. The Physics Division is part of the School of Mathematics, Physics and Astronomy. The faculty numbers 36 full-time members which is down somewhat from the figure 43 of a few years ago.

The main purpose of my visit was to discuss the laser research conducted by Dr. L. Allen, an experimental physicist. Dr. D.G.C. Jones, another senior faculty member in Physics, is investigating mode locking in gas lasers. However, he was not available the day I visited. Allen has written many papers in the area of laser research and is the author of two books on the subject: *Principles of Gas Lasers*, with D.G.C. Jones (Butterworths, London, 1967) and *Optical Resonance and Two-Level Atoms* with J.H. Eberly (Wiley, New York, 1957).

Allen has a relatively small group, consisting of himself and two or three graduate students. He is in the process of completing previous work on amplification of spontaneous emission in gas discharges and is now turning his attention to high-resolution spectroscopy and the spectroscopy of two-photon processes.

One project underway is the study of resonance fluorescence from atoms in an atomic beam excited by intense coherent radiation. In particular, effects due to the beam atoms' having a spread of velocities resulting in a distribution of interaction times is of interest and is the subject of a recent theoretical publication [L. Allen, B. Allen, and P.L. Knight, *Opt. Commun.* 20, 150 (1977)]. They studied the transient response and dynamics preceding the onset of saturation. They also extended the theory of the interaction of coherent fields with atoms to include the effect of a distribution of atomic velocities whereas earlier treatments assumed a single velocity. They calculated the inversion and in-quadrature components of the induced dipole moment for the "most probable velocity" and the velocity-averaged values. The single-velocity solutions oscillate with distance along the illuminated beam until the "saturation length" (the length of illumination required to produce a steady-state condition) is reached. The

velocity-averaged solutions smooth out the oscillations and result in a shorter "saturation length." The saturation length of a sodium beam (T = 375°C) is about 10^{-3} cm and is, therefore, unsuitable for use in this experiment since spatial variations cannot be resolved. However, a similar calculation for Ca atoms (T = 695°C) results in a saturation length of a few cm, which would allow space for instrumentation.

If the length of illumination is adjusted by cylindrical lenses and apertures so that the incident intensity goes to zero where the inversion reaches its first maximum, optical nutation and free precession of the atom can be studied simply by measuring the intensity of emitted radiation as a function of distance along the beam. The advantage of this experiment is that the measurable parameters are studied by spatial monitoring permitting, in some instances, the resolution of effects that cannot necessarily be resolved in ordinary spectral analysis. Tunable cw dye-lasers with the requisite monochromaticity and stability over the required 10^{-4} sec are available to perform the experiment on Ca atoms. The group is presently constructing an atomic-beam device to perform this and other experiments.

Another related area that Allen is actively pursuing is two-photon excitation of atoms. In particular he is studying the role of the intermediate state and residual Doppler effects in these processes. There has been a great deal of interest recently in multi-photon spectroscopy, which was the topic of several papers presented at the Ninth International Conference on Quantum Electronics in Amsterdam, 14-18 June 1976. A portion of this conference was described in a recent article (*ESN* 30-9:426). The reason for this interest is that, in ordinary single-photon excitation and subsequent fluorescence of gas atoms, Doppler effects arise, causing line broadening. However, if two photons of the same energy approach an atom from opposite directions, they will impart the sum energy independently of the atomic velocity. Therefore, all atoms excited in such a process will be excited to the same energy, and Doppler effects will be absent. Applications in high-resolution spectroscopy include precise measurements of: splitting and absolute shift of Zeeman or Stark sublevels, fine and hyperfine structure, isotope shifts, and collisional broadening and shifts at low pressures.

One way of producing two counter-propagating laser beams is to place a mirror in a single exit beam so that it reflects on itself. This method is satisfactory when two-photon excitation with photons of equal energy is desired. Allen has decided to examine interactions where the two photons are of unequal energies. This situation is of interest as the absorption coefficients can be increased by several orders of magnitude if an intermediate state is employed in a resonant manner. "Resonant excitation" here means that the energy of one photon is exactly equal to the difference between the intermediate and ground-state energies, and the energy of the other photon is exactly equal to the difference between the intermediate-state and the final-state energies. One example would be excitation of the 4D level in atomic Na by a two-photon interaction with one of the intermediate states $3P_{3/2}$ or $3P_{1/2}$. Fig. 1 illustrates the principle of resonant and nonresonant unequal-energy two-photon excitation of a three-level atom.

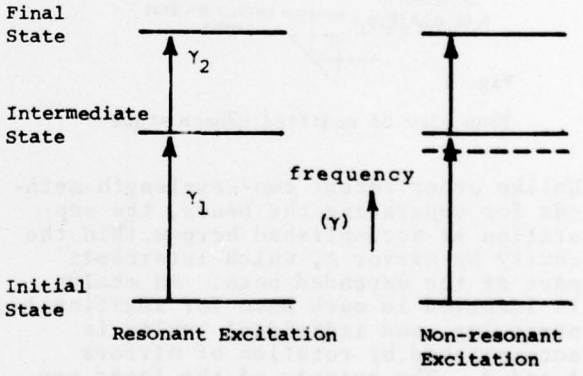


Fig. 1

Two-photon, resonant excitation of a three-level atom making use of an intermediate state, and nonresonant excitation

At resonance, Doppler effects disappear in the fluorescent spectrum of the final level for co- or counter-propagating beams. A high-resolution

spectrum of the intermediate state can also be obtained.

Allen wants to study residual Doppler effects and the role of the intermediate state in the nearly resonant situation. A source of two tunable lines is required for this work. Allen and his co-workers have developed an interesting modification to a narrow-band single-wavelength tunable dye-laser by Hänsch that provides two independently tunable beams from a pulsed dye-laser [B.R. Marx, G. Holloway, and L. Allen, *Opt. Commun.* 18, 437 (1976)]. The scheme is illustrated in Fig. 2.

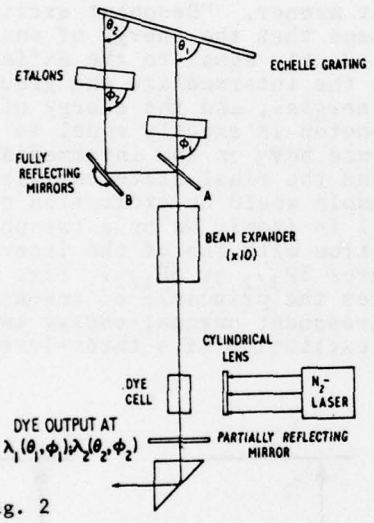


Fig. 2

Plan view of modified Hänsch stage

Unlike other recent two-wavelength methods for separating the beams, the separation is accomplished here within the cavity by mirror A, which intercepts part of the expanded beam. An etalon is inserted in each beam for additional narrowing, and individual tuning is accomplished by rotation of mirrors A and B. The outputs of the laser are collinear and occur simultaneously. The group has attained outputs of the order of 600 kW/cm^2 at bandwidths of 250 MHz with fine-tuning capability over a range of 5 GHz. Two-wavelength operation with 200-Å separation is obtainable with a mixture of rhodamine dyes 110 and 6G in acidic ethanol.

Allen took me on a tour of his laboratory, which is in the initial stages of being converted to a sophisticated flexible setup for performing many different kinds of experiments in the area of multi-photon laser spectroscopy. Now that the group has the two-wavelength tunable laser operating, the next planned step is to arrange it as well as a cw tunable dye-laser so that sample volumes can be irradiated with either source in the counter- or co-propagating mode. Atomic beams or gas cells can be used with either source. A new atomic-beam source is also under construction.

Although the size of the laser effort at the University of Sussex is small, the quality is quite impressive. Many interesting experimental results should come out of this laboratory. (Vern N. Smiley)

ACOUSTICS AT THE UNIVERSITY OF BATH

The 1977 Spring Conference of the UK Institute of Acoustics (IOA) brought approximately 150 participants to the University of Bath for a three-day meeting held on 4-6 April. Sessions covered Ultrasonic Studies of Solids and Liquids, Acoustic Properties of Materials, Neighborhood Noise, Industrial Uses of Sound and Vibration, and Underwater Acoustics.

The choice of Bath as the venue for the Conference was a particularly appropriate one, for acoustics is a subject of rapidly growing interest at the University here. Under the leadership of Prof. W.D. Chesterman, who joined the School of Physics about a decade ago, there has been considerable activity related to the application of underwater acoustics to geophysical problems. Initially this interest centered on the development and application of side-scanning sonar for observation of the sea bed. Companion studies now also include work on a high-resolution sub-bottom profiler and on the interaction of sound with sediments. A study of particular interest in the latter field is one that explores the possibility of obtaining direct information on the nature of superficial bottom deposits from the character of the bottom reflection generated by a wide-band acoustic impulse.

The work in underwater acoustics and sediments has attracted the interest of other schools at Bath. For example, in the School of Engineering P.G. Wingham and Dr. J.F. Henderson are working on problems of the instability and tow-off of faired cables towing sonar bodies at depth. Again, in the School of Mathematics, Dr. K. Walton has initiated a theoretical study of sound propagation through saturated granular media (bottom sediments).

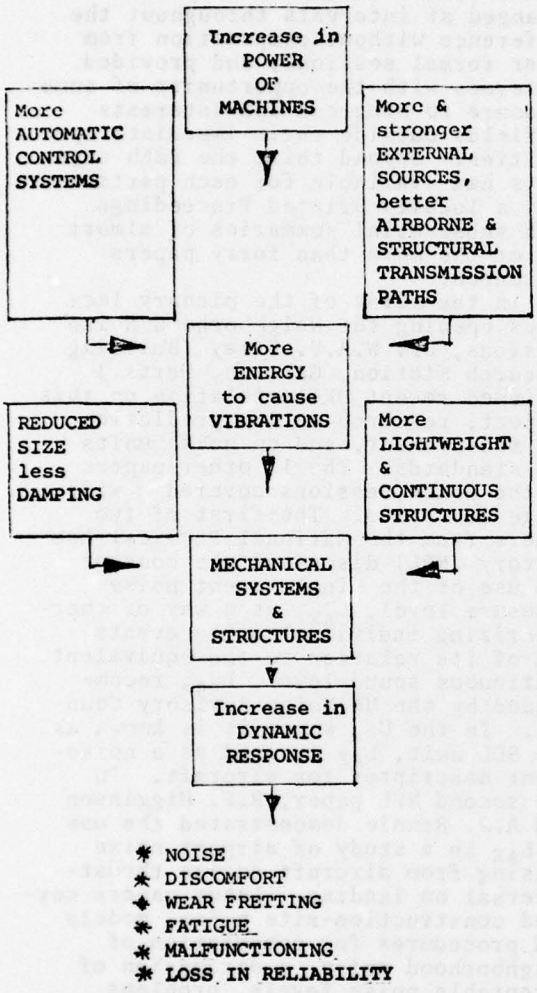
Little more than a year ago Prof. G.A. Saunders joined the School of Physics from Durham University and brought much of his equipment with him. He already has an active team and an excellently equipped laboratory for solid-state work specializing in the application of ultrasonic techniques. He has recently extended his interests to more fundamental studies of acoustic emission and particularly of emission associated with phase transitions in crystals. He is particularly concerned with the possibility that such transitions may offer as sources of acoustic emission with well-defined characteristics. He has found acoustic emission generated by the controlled polarization of some ferroelectric crystals to be reproducible, and has reported on this work at an IOA Conference on Acoustic Emission in December 1976.

In addition to the research mentioned above, the School of Engineering conducts a considerable program of work on machinery noise and its reduction. This now includes a broad study of noise in oil hydraulic systems for the UK Department of Industry. Specific objectives of this study are the establishment of criteria for the assessment of fluid-borne noise, the provision of information to assist UK manufacturers in the design of quieter units, and the assembly of a base of information useful to the UK in discussion and establishment of international standards. In another School, that of Architecture and Building Engineering, topics of study include ventilating systems, sound installation, and the like. Interest in acoustics has developed recently in the School of Material Sciences, and D.P. Almond contributed to a paper at the Conference on an ultrasonic study of electron mean-free-paths in molybdenum and tungsten.

Chesterman and Saunders were responsible for much of the IOA Conference organization, which was excellent. It featured a series of five plenary lectures, one for each of the session topics listed earlier. They were arranged at intervals throughout the Conference without competition from other formal sessions, and provided conferees with the opportunity of some exposure to progress and interests in fields outside their immediate specialties. Beyond this, the Bath organizers had available for each participant a locally printed Proceedings with substantial summaries of almost all of the more than forty papers presented.

In the first of the plenary lectures opening the Neighborhood Noise sessions, Dr. W.A.V. Utley (Building Research Station, Garston, Herts.) reviewed recent UK legislation on this subject, research on its prediction and measurement, and on noise units and standards. The 13 other papers in the noise sessions covered a wide range of topics. The first of two papers from the National Physical Laboratory (NPL) discussed the concept and use of the single-event noise-exposure level, L_{AX}, as a way of characterizing individual noise events, and of its relation to the equivalent continuous sound level, L_{eq}, recommended by the UK Noise Advisory Council. In the US, where it is known as the SEL unit, L_{AX} is used as a noise-event descriptor for aircraft. In the second NPL paper, R.F. Higginson and A.J. Rennie demonstrated the use of L_{AX} in a study of airport noise arising from aircraft engine thrust-reversal on landing. Later papers covered construction-site noise, models and procedures for computation of neighborhood noise, a discussion of acceptable noise levels, problems associated with the establishment of noise-abatement zones by local municipalities under the 1960 UK Noise Abatement Act, and specific noise problems such as boiler-houses. Significantly, four of the papers were authored by the staffs of local municipalities, about a dozen of whom participated in the Conference.

The session on Industrial Uses of Sound and Vibration was short, with only three contributions in addition to the plenary lecture by Prof. P. Grootenhuis (Imperial College). Grootenhuis first identified the current trends in engineering detrimental to a low-noise environment, which he summarized in the Table below.



He then surveyed some of the wide and diverse range of application of vibration. Examples cited included rock breakers and shaking conveyors, screens, and sieves in mineral-ore processing; drilling; sediment and material compaction; machinery-health monitoring; and a variety of medical applications.

Dr. R.W.B. Stephens (Chelsea College), in his plenary lecture introducing the session on the Acoustic Properties of Materials, discussed the broad subject of acoustics and materials. He opened with a discussion of the diagnostic uses of acoustics covering both passive and active or energetic techniques. Under the first category he included: medical uses, machinery noise, and sonic emission. In the second: sonar, echo sounding for medical and nondestructive testing, and the use of resonance or Doppler techniques. He proceeded to demonstrate the range of the subject by touching on a variety of topics including, the acoustic characteristics of quartz, the use of high intensities to affect material properties, liquid crystals, acoustic emission possibilities, and concluded with reference to work on the ultrasonic microscope.

The following papers in the session emphasized high-intensity effects. The first by W.T. Coakley (University College, Cardiff) on biological cell disintegration using ultrasonic cavitation indicated less damage to released cell contents when using 1 MHz than with 20-kHz sound for similar acoustic power inputs. Other papers were on the effects of high intensity sound on man, and the application of high intensity sound in the stimulation of plant growth. In the latter, A.E. Crawford (DDS Engineering Co., Ltd., Basingstoke) first briefly reviewed work on acoustic stimulation, noting the extensive work done in recent years in Eastern Europe, particularly in Russia and Bulgaria. He was aware in some detail of the Bulgarian work carried out by Ing. V. Berkiarov of the Bulgarian Academy of Sciences. This started in 1965 and had involved large-scale experiments with many hectares of crops including soya, alfalfa, peas, sunflowers, tomatoes, *et al.* Apparently the only root crop was sugar beet. Most of these studies had been concerned with the effects of acoustic irradiation of seed usually in water at levels near cavitation. This treatment conceivably leads to a reduction in germination time. The scale of the experiments is further shown by the size of one seed-treatment chamber, which was of 1-m diameter and 1.5-m height, and which used 19-kHz acoustic radiation with 10-kW electrical input. Increases in crop yield of 10% to 40% were claimed against controls.

Prof. A.F.G. Wyatt (Exeter Univ.) contributed a stimulating plenary lecture entitled "Liquid Helium—An Ideal Solid for Studying Phonons" (also billed as "...—An Ideal Solid for Sound Transmission") to the sessions on Ultrasonic Studies of Liquid and Solids. Few present cannot have been tempted to leave the more prosaic

areas of acoustics in which they are more or less solidly entombed to dive headlong into liquid helium. Wyatt first outlined the properties of liquid ^{4}He which render it an almost ideal material for the study of phonons. He then noted that its properties can nevertheless be profoundly affected by pressure, which changes the sound velocity and the shape of the dispersion curve affecting phonon propagation. He proceeded to discuss experiments studying the angular distribution of phonons radiated from an atomically flat surface into liquid He at 0.1 K. In addition to a narrow beam there is a broad angular background, which is not classically predicted. He went on to describe how, because of the pressure-dependence of phonon propagation in liquid He, helium can be used as a tunable high-pass phonon filter [*Phys. Rev. Lett.* 33, 1425, (1974)], and how this technique has subsequently been used to study the phonon spectra of the emission from a solid.

Chesterman's review which introduced the Underwater Acoustic Sessions centered on work at Bath on the interaction of acoustic radiation with sediments. With the aid of side-scanning sonar pictures of the seabed (due to back scattering at shallow angles), he demonstrated the possibilities of discrimination of different bottom materials—mud, sand, shingle, and rocks, and the identification of man-made features from amplitude information alone. He considered that the next advances in this field will arise from detailed study of the returned signal and that there are possibilities of further characterizing sediments in this way. He proceeded to emphasize the importance of sources using non-linear acoustics for these and related bottom-penetration studies.

The following two papers presented by Prof. C.W. Horton (Applied Res. Labs., Univ. of Texas) and Dr. H.O. Berktay (Univ. of Birmingham) reviewed work and views on the penetration of narrow, highly directional acoustic beams into sediments. Carefully conducted laboratory experiments using narrow beams from parametric sources and buried detectors suggested arrivals associated with two separate velocities in the sediment near the critical angle. These results and the possibility of surface displacement of the narrow beam were discussed at some length. Dr. N.G. Pace (Univ. of Bath) followed with a review of his work on the reflection of broad-band signals from sediments. In an earlier laboratory investigation identification of three artificial sediments, each formed from glass spheres of a different size, was achieved with a 65% probability by study of the impulse response. These studies were extended by using three carefully prepared test beds, each containing one of three carefully graded sands. For tests purpose the test-bed specimens were illuminated by acoustic pulses generated by a transient parametric source having a large bandwidth and a frequency-independent beamshape. Each test bed was large enough and the beam width small enough to allow about 200 independent samples of each specimen. The normally reflected pulses were examined for power-spectrum differences by autocorrelation techniques. Preliminary results again suggested about a 60% probability of recognition from a single return by comparison with the averages.

Two later papers in the underwater session were from the University College of North Wales, Bangor. They dealt with laboratory and preliminary field studies of shear-wave propagation in sediments (D.T. Smith *et al*) and the temperature dependence of acoustic absorption in sediments (J.D. Bennell). Interest in the work at Bangor centers on marine civil engineering applications related to the load-bearing properties of sea floor sediments. Dr. M.G. Gültepe (Bristol Univ.) followed with a discussion of the influence of interparticle forces on acoustic attenuation in sediments. Reviewing the available theoretical treatments for transmission in suspensions, he concluded that, while attenuation is a sensitive method of detecting the interparticle forces, a substantially firmer base is required before the forces can be assessed from acoustic measurement, particularly for clays such as kaolin. Dr. K. Walton (Univ. of Bath) concluded the session with a theoretical paper on propagation in model sediments, in which he took as his model a fluid-saturated cubic packing of like elastic spheres. One paper on this model has appeared recently, and a second will shortly, in the *Geophysics Journal of the Royal Astronomical Society* 48 (1977).

In a special session after those on underwater acoustics, the A.B. Wood Medal and Prize, awarded alternately in the US and UK to a young scientist for the physical sciences associated with the sea, was given to P.A. Crowther (Marconi Space and Defence Systems Ltd. Frimley, Surrey) by Mrs. A.B. Wood on behalf of the Institute. Crowther, in his Medal Lecture entitled "Underwater Acoustic Boundary Scattering," reviewed both theoretical and experimental work on surface and bottom scattering. He introduced scattering from near-surface bubbles into the surface-scattering case and estimated the required bubble populations to best fit available data. Quasi-volume scattering from soft bottom materials was introduced to assist in the explanation of bottom-surface scattering strengths.

All in all, this well-organized Conference provided another step forward for the young UK Institute of Acoustics. It reflected the energies, enthusiasm, and initiatives of its primary organizers, W.D. Chesterman and G.A. Saunders. The sessions and the on-campus location, with accommodation and all victualling, despite the proximity of the city, proved remarkably effective in overcoming possible local distractions. Perhaps, on the other hand, the Roman baths, for which the city is named, cannot be expected to compete with underwater sediments, the liquid and solid states, noise problems, and other acoustic topics, particularly in early April in England.

Copies of the Proceedings of the 1977 Spring Conference on second printing will be available from the Institute of Acoustics, 47 Belgrave Square, London SW1, at a later date.
(A.W. Pryce)

NEWS & NOTES

ONRL ALUMNI NEWS

Congratulations are in order for Leopold B. Felsen, Dean of Engineering at the Polytechnic Institute of New York, who has recently been elected to membership in the National Academy of Engineering. Dean Felsen was Liaison Scientist for Electrophysics at ONRL during 1960-61.

THE QUEEN'S BIRTHDAY HONOURS LIST

The award of Knight Bachelor (KB) has been made to the following: Kenneth Lyon Blaxter, FRS, Director, Rowett Research Institute, Aberdeen; John Wenman Crofton, Professor of Respiratory Diseases, University of Edinburgh; Professor Frederick Charles Frank, FRS, lately Professor of Physics, Bristol University; Robert Brockie Hunter, Vice-Chancellor, University of Birmingham; Rex Edward Richards, FRS, for services to nuclear magnetic resonance. The Companion of the British Empire (CBE) has been awarded to: R. Aspinall, Deputy Chief Scientific Officer, Ministry of Defence; T.G. Currie, Director, Dunstaffnage Marine Research Laboratory, Scottish Marine Biological Association; R.W.J. Keay, Executive Secretary, the Royal Society; and L.C. West, Professor of Engineering, University of Sussex. The Order of the British Empire (OBE) was awarded to: L.A.W.E. Kemp, Senior Principal Scientific Officer, National Physical Laboratory; L. Maunder, Professor of Mechanical Engineering and Dean of Applied Science, University of Newcastle upon Tyne; L.D. Rattee, Professor and Head of the Department of Color Chemistry, University of Leeds; J.F. Smith, Principal Professor and Technical Officer, Science Research Council; and N.G. Stewart, Head of Environmental and Medical Sciences, UKAEA.

PERSONAL

Dr. C.G. Caro has been awarded the title of Professor of Physiological Mechanics in respect of his post at Imperial College, University of London.

Dr. Duncan Davies, General Manager, Research and Development, for Imperial Chemical Industries, has been appointed Chief Scientist of the Department of Industry (formerly the Department of Trade and Industry). He succeeds Sir Ieuan Maddock, who was Chief Scientist of the Department from 1971 to 1974.

Dr. Paul Dean, at present Head of the Space and Air Research and Development Contractors Division of the Department

of Industry, has been appointed Director of the National Physical Laboratory (Teddington, Middlesex) from 1 October. He will succeed Sir Ieuan Maddock, who will shortly retire from public service.

Professor J.E. Dubois, Director of the Laboratory of Organic Physical Chemistry, CNRS, succeeded Professor R. Latarjet as Director of the Biology Section of the Curie Foundation Institute of Radium on 1 January 1977.

Mme Alberte Pullman, Director of Research at CNRS and Professor Bernard Pullman, Director of the Laboratory of Theoretical Biochemistry, Paris, have been nominated Doctors Honoris Causa of the Universities of Liège and of Uppsala.

Dr. J.J. Florentin has been awarded the title of Professor of Computer Science in respect of his post at Birkbeck College, University of London.

Professor R.W.K. Honeycombe, Goldsmiths Professor of Metallurgy at the University of Cambridge, has been installed as President of the Institution of Metallurgists in succession to Dr. A.J. Kennedy.

Dr. M.A. Laughton has been awarded the title of Professor of Electrical and Electronic Engineering in respect of his post at Queen Mary College, University of London.

Dr. William Mainwaring, Head of the Androgen Physiology Department at the Imperial Cancer Research Fund, London, has been appointed to the vacant Chair of Biochemistry at the University of Leeds as of 1 October 1977.

Professor Derek Robinson, at present Professor of Theoretical Physics at the University of Aix-Marseille, has been appointed to a Chair of Pure Mathematics at the University of New South Wales, Australia. He will take up his position in early 1978.

Dr. Adrian Smith, Lecturer in Statistics at University College, London, has been appointed Professor of Mathematical Statistics at the University of Nottingham from 1 October 1977.

Dr. A.J. Smith, Reader in Geology at University College, London, has been appointed to the Chair of Geology at Bedford College, London, from 1 October 1977.

The Institute of Physics, London, and the German Physical Society have announced the award of the 1977 Max Born Medal and Prize to Professor W.E. Spear of the University of Dundee for his work on charge transport in non-crystalline semiconductors. The presentation will take place in September 1977 during the annual meeting of the German Physical Society in Karlsruhe.

OBITUARIES

Professor Archibald Vivian Hill, CH, OBE, FRS—"A V" to most of his colleagues—died 3 June at the age of 90. He was the first Nobel Laureate in Physiology from Great Britain. Hill began his training as a mathematician but turned to another science wherein this training would not be wasted. He chose physiology and began with a modification of Nernst's theory of excitation. It was suggested to him that he investigate the heat production of muscles during activity. After a tour of German laboratories in 1911, he began the research on the heat evolution of muscle and nerve which became his life's work and eventually led to his sharing the Nobel Prize for Physiology and Medicine for 1923 with Otto Meyerhof, of Kiel. After WWI, Hill was Professor of Physiology at Manchester and in 1923 was appointed Professor at University College, London. In 1926 he was made Foulerton Professor of the Royal Society (at University College), where he remained until his retirement in 1951. During his lifetime he served in various consultative positions to the British Government. He was an editor of the *Journal of Physiology* and even served as a Member of Parliament for the University of Cambridge from 1940-1945. He held many honorary posts and received many honorary degrees from many countries.

Sir Graham Sutton, CBE, FRS, Director-General of the Meteorological Office from 1953 to 1965 and Chairman of the Natural Environment Research Council from 1965-1968, died 26 May at the age of 74. After a varied career in a number of government departments, Sir Graham brought to the Meteorological Office a great enthusiasm for research. Under his directorship, the

Met Office grew in scientific importance and in the services it gave to both the government and the general public. Sutton's earliest researches were devoted to the study of atmospheric turbulence, and it remained his favorite aspect of meteorology. After his retirement from the Met Office, he was persuaded to become the chairman of the newly established Natural Environment Research Council for a one-year period. However, this grew to three years, and thereafter for another three he served as a member with special responsibilities for hydrology and the atmospheric sciences. Sir Graham was the author of many outstanding publications, among which are: *Micrometeorology* (1953), *The Science of Flight* (1950), *Mathematics in Action* (1953) *Meteorology and Weather Forecasting* (1959), *Understanding Weather* (1960), and *The Weather* (1970).

Sir Landsborough Thomson, CB, OBE, an outstanding medical and biological research administrator and an ornithologist, died on 9 June at the age of 86. Although probably better known for his ornithological research, activities, and publications, our interest in him stems from his connection with the British Medical Research Council. He served for nearly 40 years as deputy to three successive Secretaries of the Council, and in 1936 he became Principal Assistant Secretary. He progressed to Under Secretary in 1946 and to Second Secretary in 1949. After his retirement in 1957, he continued to serve part-time on special duties at the Council's headquarters, remaining Chairman of the Board of Public Health Laboratory Service that he had done so much to found. In addition to four books on birds, he was the author of a history of the Medical Research Council, *Half a Century of Medical Research*, which was published in two volumes in 1973 and 1975.

ONRL REPORTS

R-5-77

EUROPEAN DEVELOPMENTS IN THE Na/S HIGH-TEMPERATURE BATTERY FOR AUTOMOBILE PROPULSION AND ENERGY STORAGE by A. Sosin

The sodium-sulfur battery is a leading candidate for future use in the propulsion of automobiles, vans, buses, and trains and for energy storage and load-leveling by electrical utilities. This report presents a brief description of the fundamentals of the operation of the battery, with indication of some considerations which control its development into an important technological system. The status of the battery development in England, France and Germany is then reviewed.

C-3-77

ELECTRICAL PHENOMENA IN BIOLOGICAL MEMBRANES: A SYMPOSIUM by J.B. Bateman

This report provides a breakdown of topics considered at a symposium on "Electrical Phenomena at the Level of Biological Membranes" constituting the 29th International Meeting of the French "Société de Chimie Physique". The interdisciplinary nature of the symposium is illustrated by summarizing the proceedings in terms of "biological" and "nonviable" systems. The attempt is made to present the substance of the various contributions against a background that will make the report accessible to the general reader. It is suggested that the admirable goal of a truly interdisciplinary exchange was not achieved despite the evident efforts of some of the speakers to escape from the limitations of their own specialities.

C-4-77

CONFERENCE ON LUMINESCENCE PROCESSES IN CATHODE-RAY TUBES AND LAMPS, WEYBRIDGE, SURREY, ENGLAND, MARCH 1977 by J.H. Schulman

This Europhysics Study Conference on phosphors dealt with inorganic-impurity-activated phosphors used in cathode-ray tubes, fluorescent lamps, and x-ray screens. Most emphasis was given to the saturation effects in cathode-ray excitation of phosphors and the general problems of energy absorption, localization, transfer and emission in these phosphors.